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TECHNICAL DESCRIPTION OF THE RADAR K-1M IA.250.000 TO

TU-16

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TECHNICAL DESCRIPTION OF THE RADAR K-1M

CONTENTS

Разработ. Проверил

Разраб.		
Изм.	Кол.	№ прик.	Подпись	Дата	Изм.	Кол.	№ прик.	Подпись	Дата	Проверил

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CHAPTER I

Radar K-IM purpose

The Radar K-IM forms part of the radio control system "Comet" and is located on the type "KC" missile.

In transporting the missile under fighting conditions, a specially equipped mother-ship is used; the missile should be supported from a lug under the mother-ship plane.

A special guidance Radar K-IIM is located in the mother-ship.

The Radar K-IM provides:

I. The missile guidance by controlling the autopilot in two regimes:

"A" regime - the beam-riding guidance.

"B" regime - the semi-active homing.

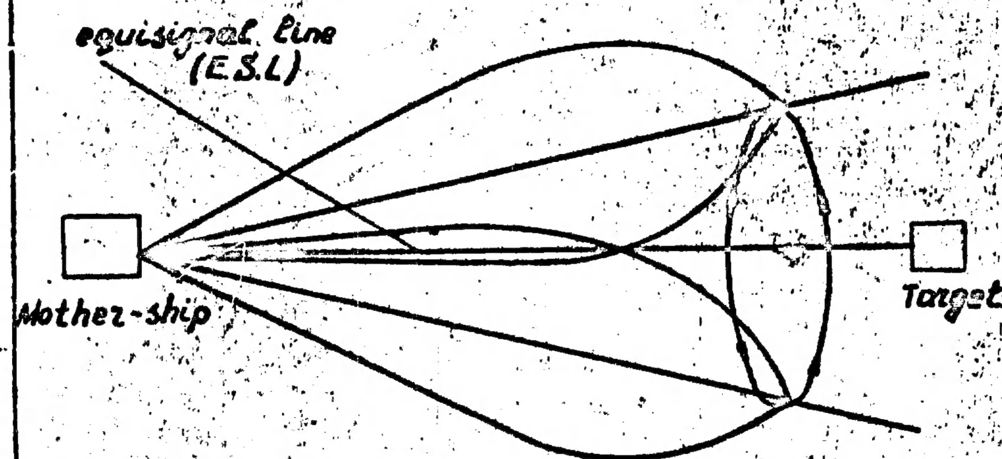
2. Tracking beacon signals, determining missile position in the beam, distance between the missile and the target and communicating command N 2 realization and target damage accuracy.

CHAPTER II

K-IM Operation Principle

When mother-ship is in flight, the Radar K-IIM carried out the search of target. After detecting and selecting the target, the Radar K-IIM starts looking on and tracking the target.

Beam of the Radar K-IIM transmitter antenna is [illegible] conically due to the antenna exiter rotating at [illegible] cy =10= :



The half- power line of the radiation pattern serves as an axis of this cone. So appears a spatial line (equisi-gnal line) which is used for missile guiding.

When the distance between the mother-ship and the target reaches a predetermined value, "KC" jet engine is fired and "KC" is dropped.

Radar K-IM operates in 3 regimes:

I. Autonomy regime (beam - entry regime);

2. "A" regime (beam-riding guidance);

3. "B" regime (semy-active homing).

I. Autonomy regime

The autonomy or beam-entry regime is lasting 39 ± 2 sec. from the moment of dropping the missile until the missile enters the beam of K-IIM Radar.

In the autonomy regime the Radar K-IM does not control the missile flight; the latter is controlled by the prog-ramme controller of the autopilot. Unit KI-6M time-motor initiates the command N I and commutates the autopilot into course and elevation radar guiding in 39 ± 2 sec. after dropping the missile.

2. "A" regime

The regime "A" starts from the moment of realising the command N I and is lasting up to "B" - regime switching on. The missile is radio controlled by the course and elevation channels.

In this regime the Radar K-IM provides driving voltages to the autopilot.

The dependance of the voltage value on the missile deviation from the equisignal line is linear, and voltage polarity conforms to the missile deviation direction relative to the E.S.L.

The driving voltages actuate the control surfaces through the autopilot and return the missile to the equisignal zone.

Let us examine fig N 2. K-IIM antenna scanning beam section on the horizontal plane is shown on fig. N 2. If the missile position is on equisignal line the U.H.F. signal power remains invariable during the scan period.

In other directions (for example Mdirection) mixer "A" input signal power will change in accordance with radiation pattern position changing.

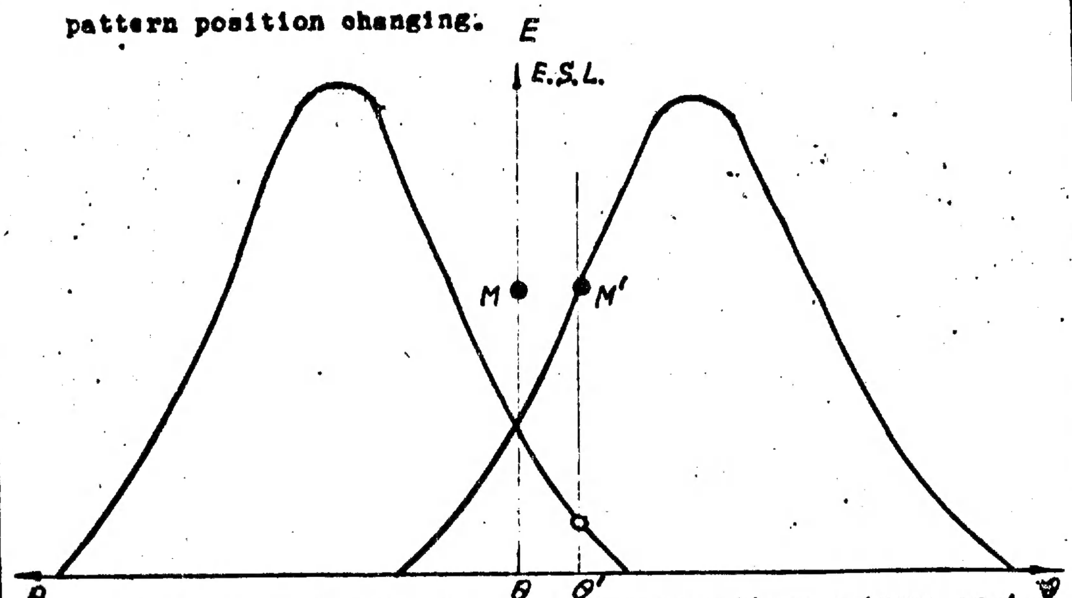


Fig.N 2. Radar K-IIM antenna radiation pattern extreme positions in the Cartesian co-ordinates.

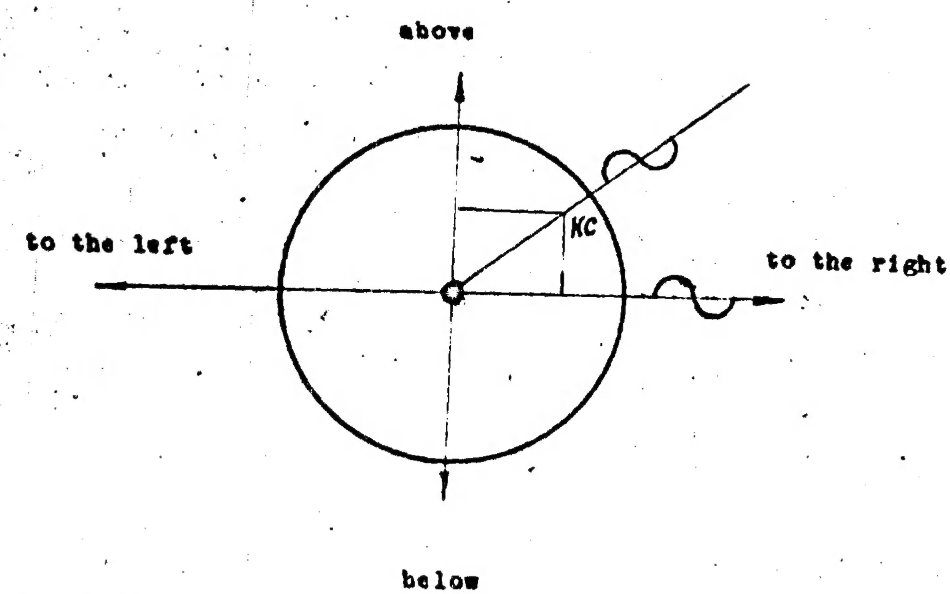


Fig.N 3. K-IIM antenna beam cross section on the plane, wich is normal to equisignal line.

So if the missile is in the point M (fig.N 2) and the K-IIM antenna beam is rotatiøng, the electric field strength in the point M will be sinusoidal amplitude-modulated at the frequancy of the rotating beam. The modulation percentage is determined by the missile "KC" -to-E.S.L. deviation and increases with the angle "θ" increase. So, the modulation envelope is proportional to the angle deviation in this case. And for small angles "θ", which are operational angles, this responce may be considered linear. In addition, the amplitude of field strenght envelope is proportional to a middle level of U.H.F. signal in this point.

The envelope of A.M. input signal, produced by KI-6M unit of Radar K-IM, is Known as error signal.

The same linear deviation from the equisignal line at different distances between the missile and the Radar K-IIM, i.e. between the missile and mother-ship, produces different modulation percentage.

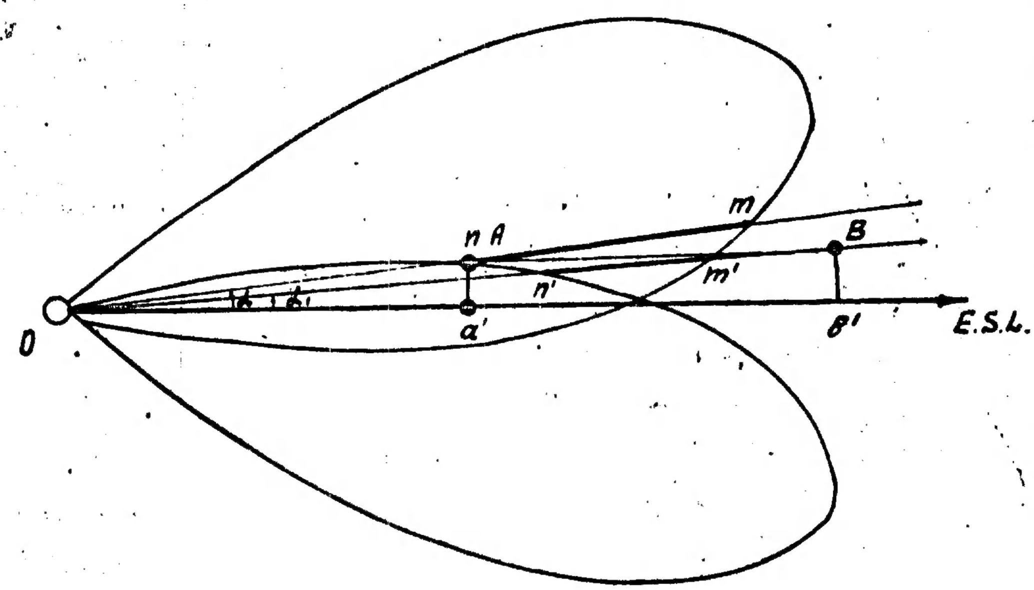


Fig. N 4.

Fig. N 4 shows, that the same "KC" -to-E.S.L.range deviation (a'A and в'B) produces nonequal changes of U.H.F. signal power, when Radar K-IIM is scanning (nm ≠ n'm').

It is obvious, that percentage of U.H.F. signal modulation and hence the error signal will be less at the missile-to-Radar K-IIM range being equal to OB.

With a view to obtain driving voltages proportional to "KC"--to-E.S.L. linear deviation at different distances between

the missile and the mother-ship a program, increasing driving voltage transconductance, is provided in the Radar K-IM unit KI-6M. Driving voltage-to-modulation percentage relation is known as transconductance of driving voltage.

The regime A transconductance increase is carried out by setting the range potentiometer, which varies the unit KI-6M detector gain in dependence on the time.

The moving of range potentiometer slide is carried out by means of the time-meter and lasts till missile flight stage.

The gain-to-time dependence is in accordance with the missile speed so that the driving voltage value does not depend on the angle deviation, but it depends on linear missile-to-E.S.L. deviation.

To exclude driving voltage transconductance dependence on U.H.F. signal average level (which depends on missile-to-mother-ship range) and to get driving voltages conforming to "KC" coordinates relative to E.S.L., the A.G.C. is provided in the synchronization channel. This A.G.C. maintains constant value of the videopulses in overall signal power band.

Driving voltage polarity, which is determined by the missile position in Radar K-IIM beam (left-right-above-below) is obtained by comparing error signal phase to Radar K-IIM reference voltage phase.

It's necessary in this case to relay Radar K-IIM reference voltages to the missile (i.e. to carry mother-ship axes of coordinate to the missile).

In every point of the space, where the missile is position

phase difference between the error signal and the reference voltage determines angle of vector, which inter-connects this point and the equisignal line and lies on the plane normal to the E.S.L. (see fig N 3). Reference voltages are transmitted to the missile by means of the recourence frequency ("HO") modulation of pulses radiated by the Radar K-IIM. The sinusoidal modulation percentage is equal to I.I. %.

Regime "A" reference voltages are obtained from the reference generator, which is geared to the antenna K-IIM exiter and produces sinusoidal voltage to modulate Radar K-IIM U.H.F.signal reccurence frequency.

Fig.N 3 shows, that for every point of space lying on the beam cross-section plane in the same distances from the E.S.L. the field strength modulation percentage is constant and the phase difference between error signal and reference voltage determines the orientation of the point relative to the E.S.L. of the K-IIM antenna.

It's always possible to provide phase-shifting of the Radar K-IIM - Radar K-IM system so, that error-signal to reference synphasing will be carried out in the only definite missile position in scanning beam field. The error signal phase relative to reference voltage phase will be counted out unambiguously on condition that reference phase is constant at any direction of missile deviation. This requirement is met by Radar K-IIM transmitting antenna gyro-stabilizing. It excludes phase deviation when random mother-ship evolutions are happened.

So, A.M. envelope (or error-signal) and reference voltage

contain complete information of the co-ordinates of missile, to wit : error-signal amplitude is proportional to missile-equisignal line range ;

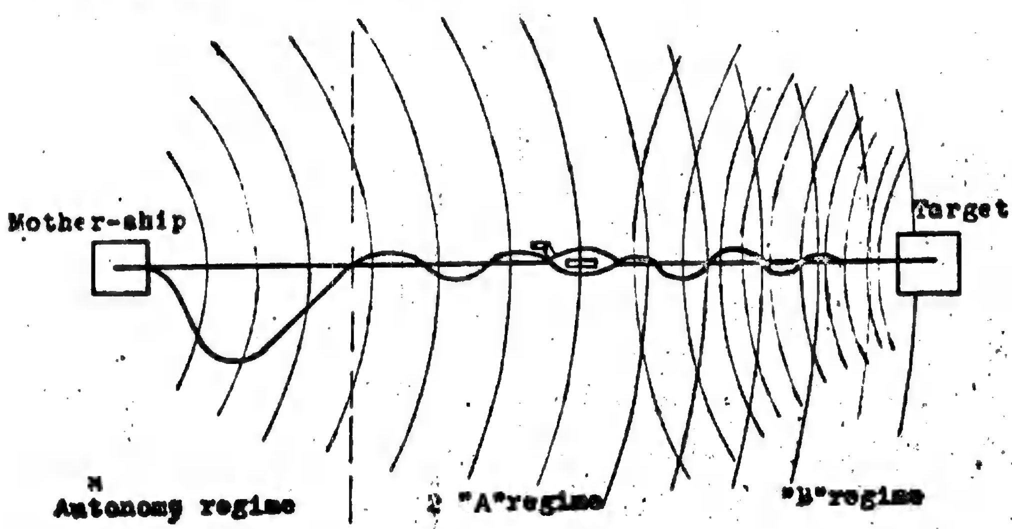
- phase difference between error voltage and reference voltage determinds angle orientation of the missile on the cross-section plane, the pole of which is on the Radar K-IM antenna E.S.L.

It is necessary only to make suitable transformations to detect the missile co-ordinates.

The unit phase-detectors are transforming this information into driving voltages of the course and elevation channels.

3. "B" Regime

The Regime "B" starts from the moment of command N 2 operating and is continuing till the missile guidance stops.



Autonomy regime,"A" Regime,"B" Regime

Fig. N 5.

In this regime missile "KC" homing is carried out also in two channels (course and elevation) by means of the "B" antenna and the "B" receiver, wich receives signal reflecting from target (see.fig.N 5).

Command N 2 is initiated, when echo-pulse level becomes equal to a preset value, but no sooner that 200±8 secs. after dropping.

The signal amplitude modulation is provided by means of the antenna "B" scanning. Reference voltages are taken from the reference generator, which gears with the motor, rotating the antenna exiter. Rhase difference between the reference voltage and the video-pulses A.M. envelope is determined by the target orientation relative to the E.S.L., and the envelope amplitude is proportional to the angle deviation of the antenna "B" equisignal line from the target direction.

To exclude driving voltage transconductance dependence on the echo-pulses signal power, an A.G.C. is provided in K1-8M receiver. "B" regime driving voltages are produced and their effect on the missile autopilot is identical to one of the "A" regime. For the purpose of increasing noiseproof feature of the Radar K-1M in the "B" regime, the K1-8M unit is strobbed, i.e. it is opened only in the moment of echo-pulses arrival.

CHAPTER III

THE RADAR KI-1M BLOCK DIAGRAM

The purpose of the Radar units and its arrangement in the missile "KC"

The Radar K-IM, arranged in the missile "KC", is made as separate units, which are interconnected and connected with the mother-ship through the distribution box KI-13M and by means of separate multiwire and coaxial cables.

The units KI-4aM, KI-46 M, KI-5MP, KI-6M, KI-CM, KI-9M and KI-10M are placed in the special damped framework, which preserves the units from sharp blows and shoks.

The unit-type construction of the Radar makes it easy to produce and tune industrially and permits replacement of separate units, when they are in operation.

The tuners, the control devices and the monitoring jacks, which are essential during the operation, are placed on the front panels of the units and inscribed accordingly.

The coaxial and multiwire cables and their sockets are marked to avoid wrong connection.

The framework with its units is installed in the top nose part of the missile "KC" on the special frame by means of the studs, which go through the framework claw dampers and are screwed by the nuts.

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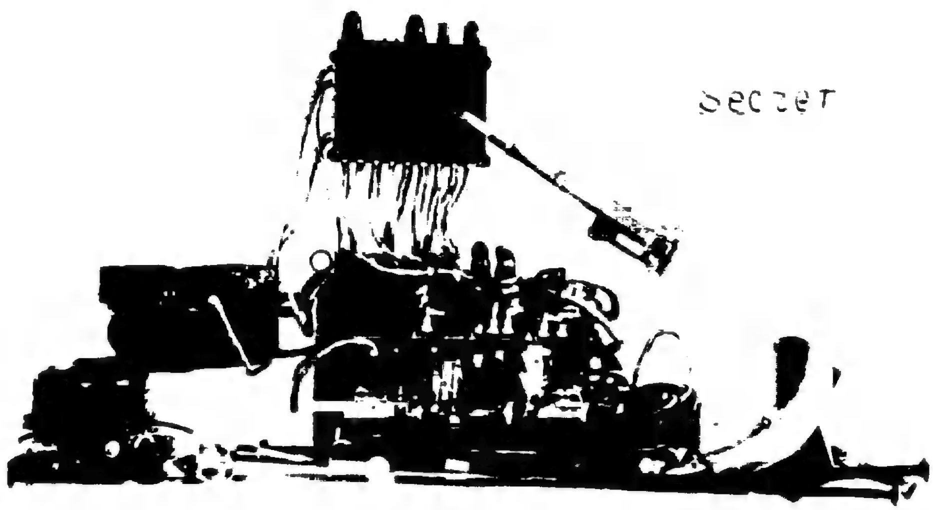

Fig.N 6. Radar [illegible] general view

I. Unit XI-IX

The "A" antenna provides a pick up of the guiding signals, which are transmitted by the mother-ship Radar XI-IM. The antenna is placed in the back part of the "XC" top fin dome.

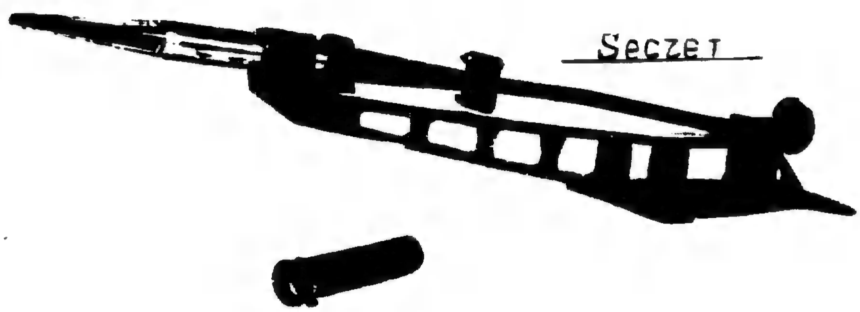

Fig.№ 7 - "A" - antenna K1-1M

2. Unit K1-3M

The waveguide channel is provided for transit the U.H.F. signals from the "A"-antenna to the mixer K1-4aM input. The waveguide is laid along the leading edge of the fin and along the right board of the body. The waveguide shape is determined by displacement of each section in the missile "KO" body.

The waveguide ends with a flexible section to connect with the unit K1-4aM in the nose compartment.

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Fig. [illegible]. [illegible]-waveguide KI-7M.

7. Unit KI-4aM and unit KI-46M

The A-mixer and the B-mixer are provided for:

a) converting R.F. signals into I.F. signals

b) R.F. decoupling between the antenna KI-1M and KI-7M. The decoupling excludes entering of the main signals transmitted by the Radar K-IIM into the homing receiver.

The units KI-4aM and KI-46M are placed on the right side of the damping framework. They have external tuners to tune the crystals, the klystron and the attennators.

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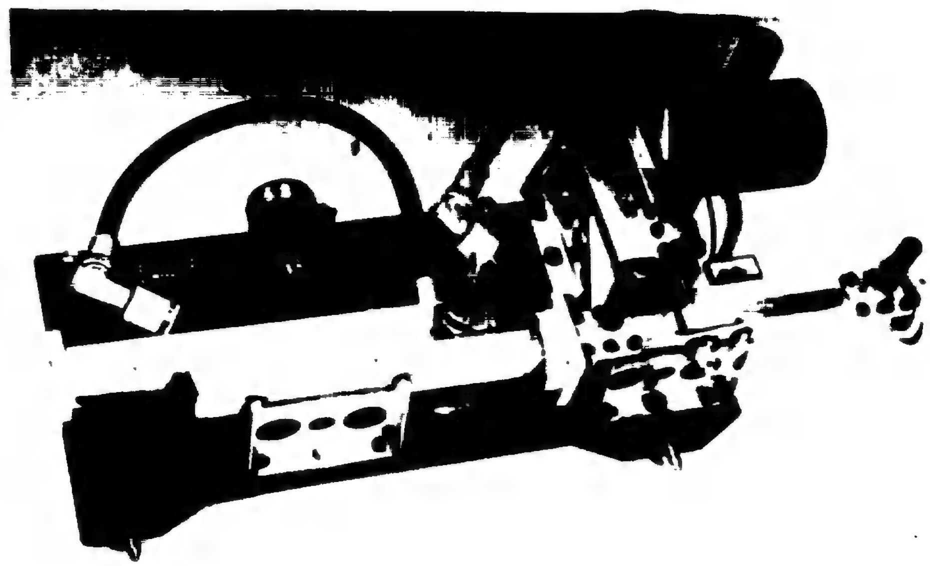

[illegible] Unit [illegible]

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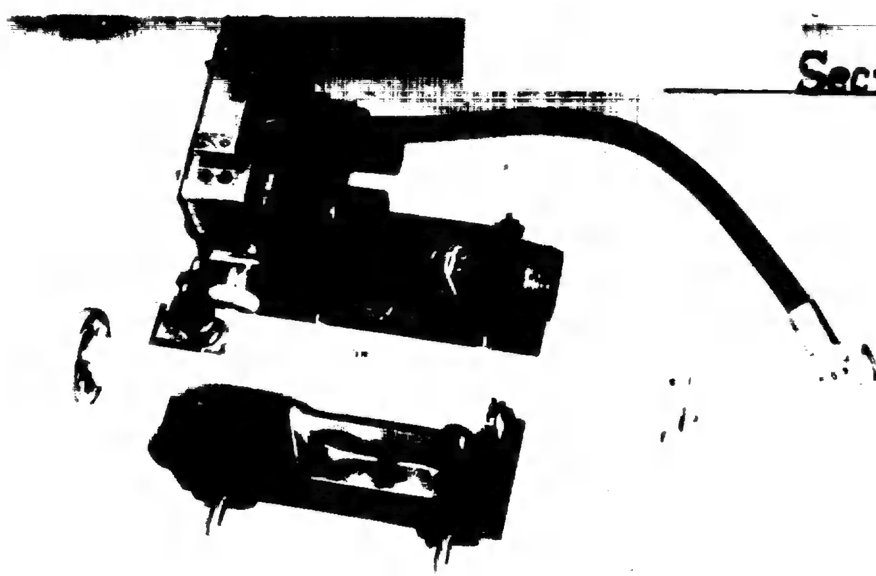

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4. Unit KI-5MP

The unit KI-5MP with the unit KI-4aM form a superheterodyne receiver for the A-regime operation. The unit KI-5MP is provided for amplifying input R.F. signals, recurrence frequency and amplitude modulated and for separating from this signals:

a) the voltage controlling the klystron frequency (A.F.C. channel);

b) videopulses, amplitude modulated by an error-signal sinusoide (error-signal channel);

c) demodulated video-pulses of synchronisation, from which the reference voltages are separated (synchronization Channel);

The unit carries out the A.F.C. of the klystron.

The unit KI-5MP is placed in the damped framework pocket and has the following tuners:

- the error-signal amplitude tuner;
- the natural frequency tuner of the synchronisation blocking-generator;
- the tuner of the A.F.C.

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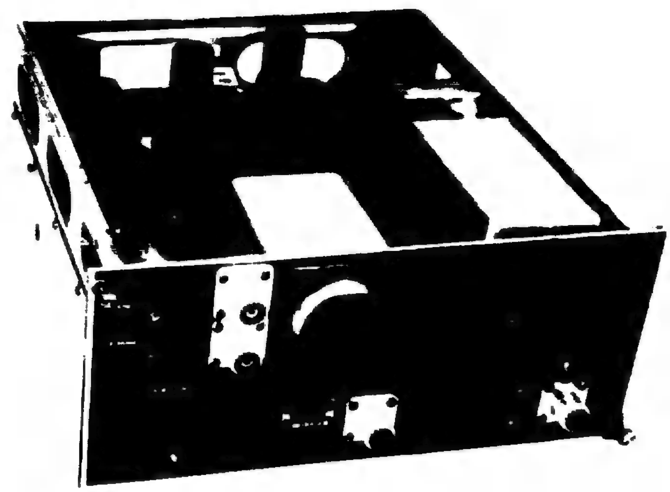

Fig.N II. Unit KI-5MP.

5. Unit KI-6M

The unit KI-6M provides the autopilot control and carries out the following functions:

a) separation of the A-regime reference voltages from the recurrent frequency modulated input pulses, which are fed from the unit KI-5MP synchronization channel output. The reference voltages are led to the tracking beacon.

b) separation of the error-signal from the A.M. video-pulses, which are supplied from the unit KI-5MP and unit KI-8M error-signal channel outputs. The error-signal is also led to the tracking beacon and to the monitoring jack.

c) produces the driving voltages of course and elevation channels, which control the autopilot.

d) produces the synchro-pulses to synchronize the units K1-9M and K1-12M;

e) interlocks the command N 2 during the 200 ± 8 secs. time period after dropping. The unit K1-6M is placed in the damped framework pocket and has the tuners:

a) driving voltages of course and elevation channels balancing,

b) A-regime and B-regime gain control;

c) control of the phase and amplitude of reference voltages.

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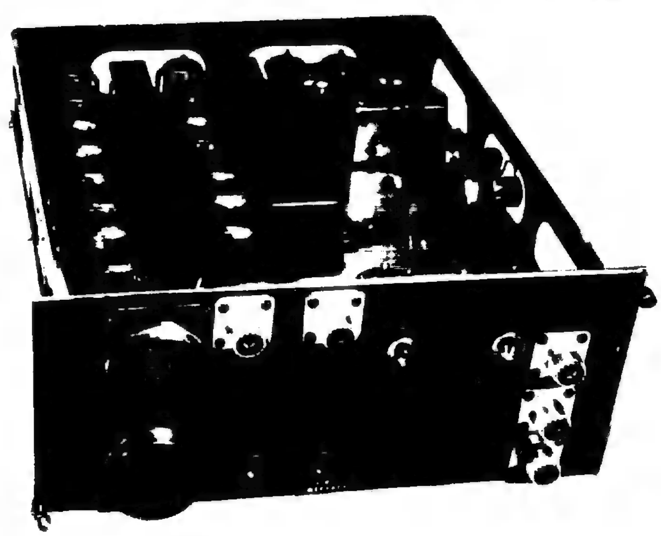

Fig.N 12. The unit K1-6M

6. Unit KI-7M

The "B" - antenna KI-7' is placed in the nose compartment of the missile "KC" and is connected with the "B" - mixer KI-46M by the flexible wave guide.

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Fig. № 13. The unit KI-7M

7. Unit [illegible]

The unit KI-8M with the unit KI-46M form a superheterodyne receiver for B-regime operation. The unit KI-8M amplifies input R.F. signals and separates from them video-pulses amplitude modulated by the scanning frequency "Я" at feeding the unit [illegible] input. The unit KI-8M injects also output video- [illegible] the unit [illegible] [illegible] in the echo-signal

locking on and tracking and to produce the command ...

For the purpose of increasing the noiseproof feature the unit is strobbed by the unit KI-9M output positive pulses of 2 μsec length.

The unit KI-8M has the following external tuners:

a) manual gain control,

b) error-signal output pulse amplitude.

The unit KI-8M structure is made as two separate sub-units: the unit KI-8M placed on the unit KI-46M plate and the unit KI-86 M placed in the framework pocket.

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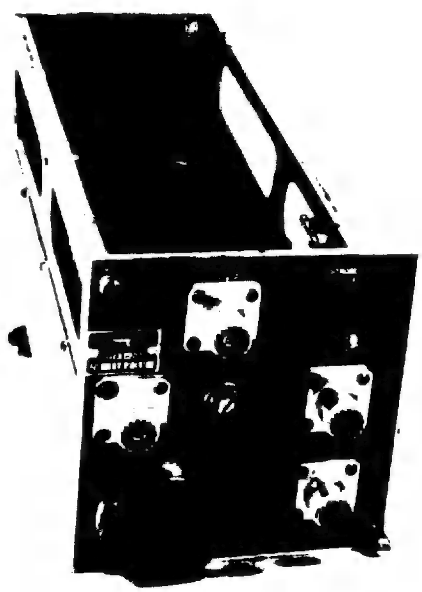

Fig.N 14. The unit KI-8M

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8. The [illegible]

The unit [illegible] provides [illegible]
tion of the echo-[illegible] from the [illegible].
The unit carries out the following functions:

a) searching of the [illegible] within the range band between 120 ± 20 μ[illegible] narrow strobe, which provides [illegible] of feature,

b) locking on of [illegible] the above-mentioned band and [illegible] from [illegible] ± 20 [illegible]sec to 1.6 ± I. [illegible],

c) produces the [illegible].

The unit has the [illegible]

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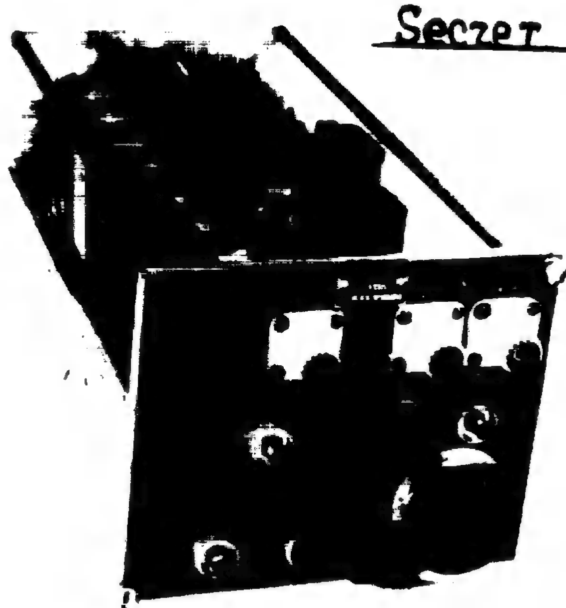

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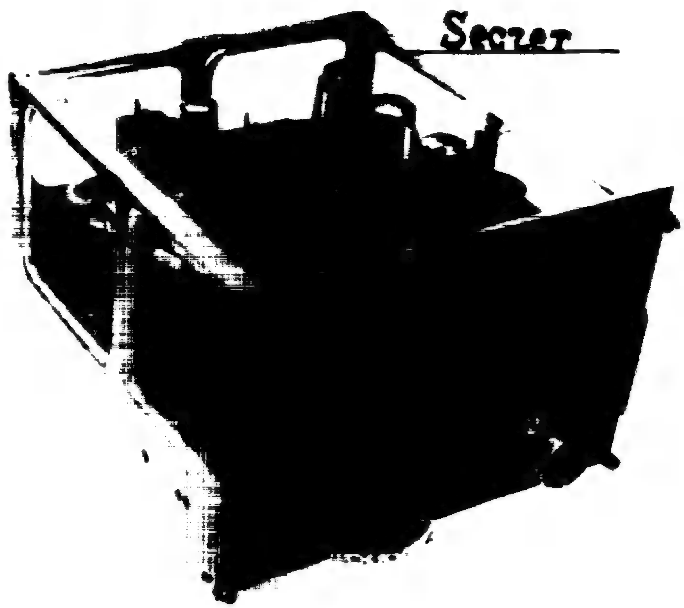
9. Rectifier KI-10[illegible]

The [illegible] KI-10[illegible] provides transformation of the a.c. [illegible] v 4[illegible] voltage into d.c. voltages to supply the Radar KI-M units [illegible] with the exception of the unit K[illegible]-12[illegible]).

The unit has tuners which control the regulated voltage values [illegible] v., -[illegible] v. and +[illegible]v. and are located on the front panel. The unit is [illegible] in the separate pocket of the damped framework.



[illegible] The unit [illegible]-10[illegible]

[illegible] antenna KI-11M

The unit K[illegible]-11M is placed in the small dome, which is located above the missile [illegible] fin. The antenna KI-11M [illegible] tracking bea[illegible] .F. signals to the mother-ship.

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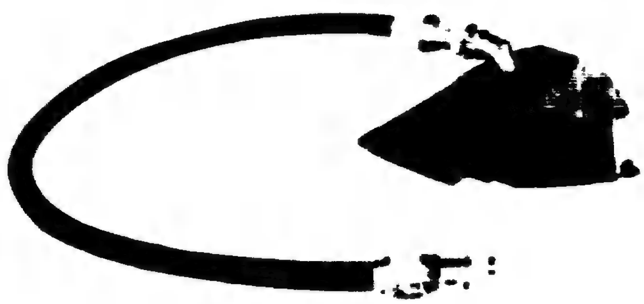

Fig. 17. The unit [illegible]

11. The [illegible]

The unit [illegible] provides [illegible] of the time [illegible] P.V. pulses as a response to the [illegible] pulses. The average pulse time [illegible] equal to [illegible] sec in the "A" regime and can be varied [illegible] on an "Ю" - frequency error-signal amplitude.

The regime "B" time delay of [illegible] is constant and is no more than [illegible] regime B time delay is practically absent.

The unit is placed on the [illegible] part of the large "KC" fin dome.

[illegible] turned.

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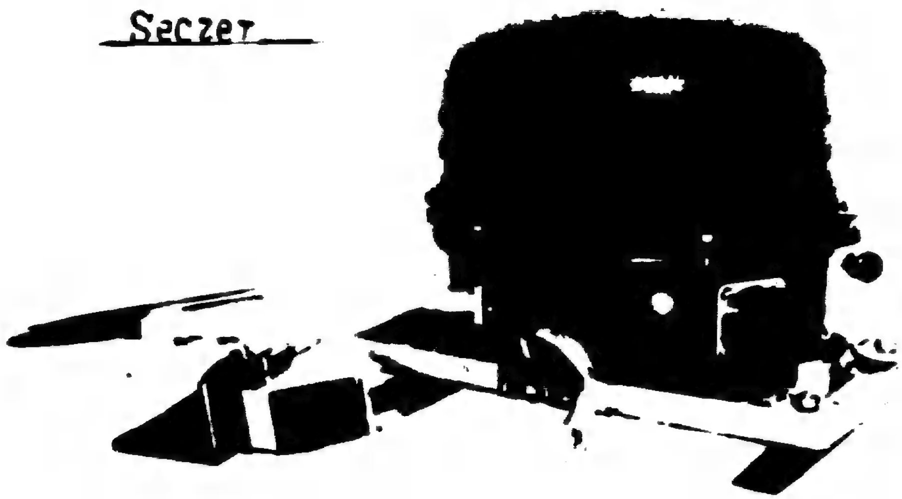

[illegible] distribution box

The unit [illegible] provides

a) inter_connection between the [illegible] separate units

b) connection with the autopilot

c) connection between the Radar [illegible] and the mother-ship equipment

d) connection with the monitoring board [illegible]

The unit is installed on the back wall of the damped framework and is fastened to it with four screws

The potentiometers, which control the output voltages of the [illegible] [illegible] and [illegible], are placed on the unit [illegible] wall.

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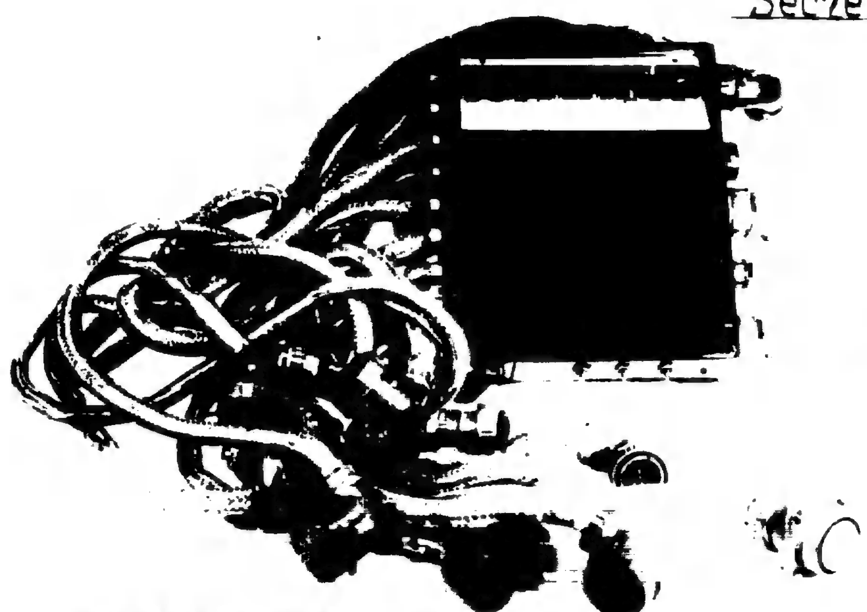

The multiwire and coaxial cable sets provide connections between the separate units.

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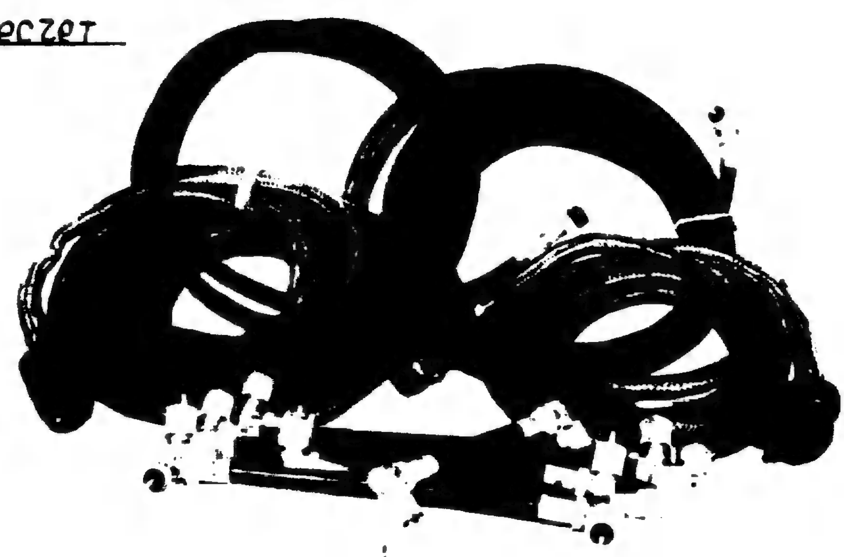

Fig. N [illegible]. [illegible] cable set.

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[illegible] Damped framework

The damped framework is provided for arrangement and fastening of the units KI-4aM, KI-46M, KI-5MP, [illegible], [illegible], KI-9M and KI-10M. The shock-absorption provides normal operation of the units. The damped framework with its units is installed in the missile "[illegible]" nose compartment on [illegible] special shock-absorbers.

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CHAPTER IV

RADAR K-1M FUNCTIONAL DIAGRAM

Radar K-1M functional diagram is in Appendix N 1 (Book of Radar K-1M Elementary Diagram).

§ 1. A - antenna K1-1M

The unit consists of the following parts:

1) Waveguide adapter;
2) Round waveguide;
3) Dielectric rod.

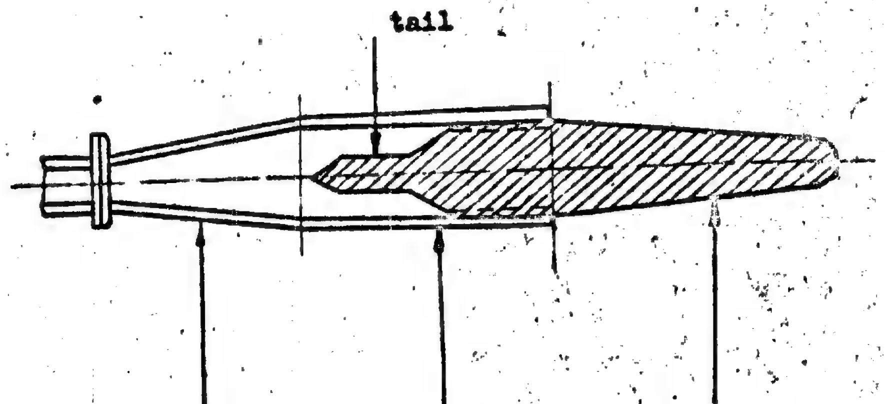

Fig.23

U.H.F. rotating polarization electro-magnetic wave, transmitted by the Radar K-IIM antenna, is picked up by the dielectric rod. The tail of the rod transforms circular polarization wave into H_{11} mode of a linear polarized wave. The waveguide adapter transforms the H_{11} wave mode into the H_{01} wave mode and channels it to the K1-3M waveguide input. The antenna radiation pattern is shown on the fig.N 24. Half power beam width is equal to 30° ± 2°.

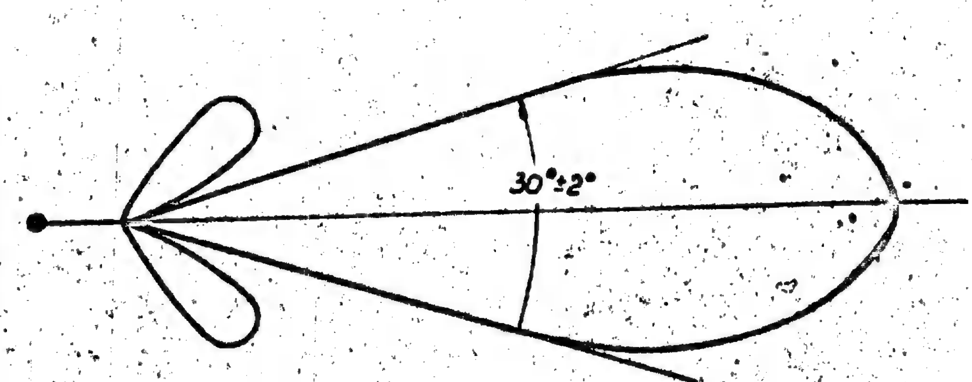

Fig.24

§ 2. Waveguide K1-3M

The Wavequide provides channelling of the U.H.F. pulse signal from the "A" antenna to the unit "K1-4 input. The Waveguide of the Radar K-1M, installed in the missile "KC", consists of 7 separate sections, which are interconnected and form a definite configuration. To decrease power loss the waveguide internal surfaces are silver-plated. Operational frequency band of the wavequide is 4k ± 60 mc. The Standing wave ratio of the waveguide is less than 2,5 and loss is less than 3 db.

§ 3. "A" mixer KI-4aM

U.H.F. signal, received with the "A" antenna, is channeled through waveguide to the crystal mixer. C.W. heterodyne signal is fed to the crystal mixer Heterodyne power level is adjusted with the atten Klystron frequency is trimmed by A.F.C. of "A" The crystal detector mixes the input signal fre with the klystron frequency and gives many vari frequency combinations and their harmonics and them to the receiver K1-5MP input through cable (plug N 30).

§ 4. "A" receiver

The unit consists of the followin

1. Input circuit, which is common for three channels;

2. Synchronization channel, consisting of:

a) 4-stage I.F. Amplifier, which is used for the error-signal channel also (tubes: Л1,Л2,Л3,Л4);

b) Detector - Л12 (left half);

c) Video amplifier - Л12 (right half) Л-17 (right half) and Л18;

d) Cathode follower - Л19 (left half);

e) Blocking-generator - Л19 (right half).

3. A.F.C. channel, consisting of:

a) 6-stage I.F. amplifier - Л1,Л2,Л3,Л4,Л5,Л6 (tube Л6 serves as a clipping amplifier);

b) Frequency discriminator - Л7;

c) Video-amplifier - Л8 (left half);

d) Cathode follower - Л8 (right half);

e) Detector-Л9 (left half);

f) Cathode follower - Л9 (right half);

g) Transitron generator - Л10;

4. Error-signal channel, consisting of:

a) 4-stage I.F.amplifier - Л1,Л2,Л3,Л4;

b) Error-signal detector - Л12 (left half);

c) 2-stage video-amplifier - Л12 (right half) Л11 (left half);

d) Cathode follower - Л11 (right half);

e) A.G.C. detector - Л13 (left half);

f) A.G.C. cathode follower - Л13 (right

g) A.G.C. diode clipper - Д17 (left half).

Various frequency pulses are fed to unit input through the cable N 30. Input circuits of the unit select I.F. signal among these pulses. After amplifying by 6-stage I.F. of A.F.C. channel and clipping pulses go to the frequency discriminator input. The discriminator reacts on the frequency value of the pulses. If the input frequency is higher than the intermediate frequency, output voltage of the discriminator is positive and if the input frequency is lower than the intermediate frequency, the output voltage becomes negative. This permits to control frequency of the klystron. Output discriminator pulses after amplification and rectification are fed to the input of the transitron generator, which generates sawtooth voltage and applies it to the klystron reflector, when the searching regime takes place. When the negative voltage, applied to the grid of the tube Д10, reachs - 4v, transitron oscillation is stopped and the tube begins operating as a direct-current amplifier (in the A.F.C. regime).

Let us examine two operational regimes of the A.F.C. system: search regime and autocontrol regime.

1. Searching regime

When there is large deviation between the difference frequency and the middle frequency of I.F. cascade the video-pulses are absent at the discriminator

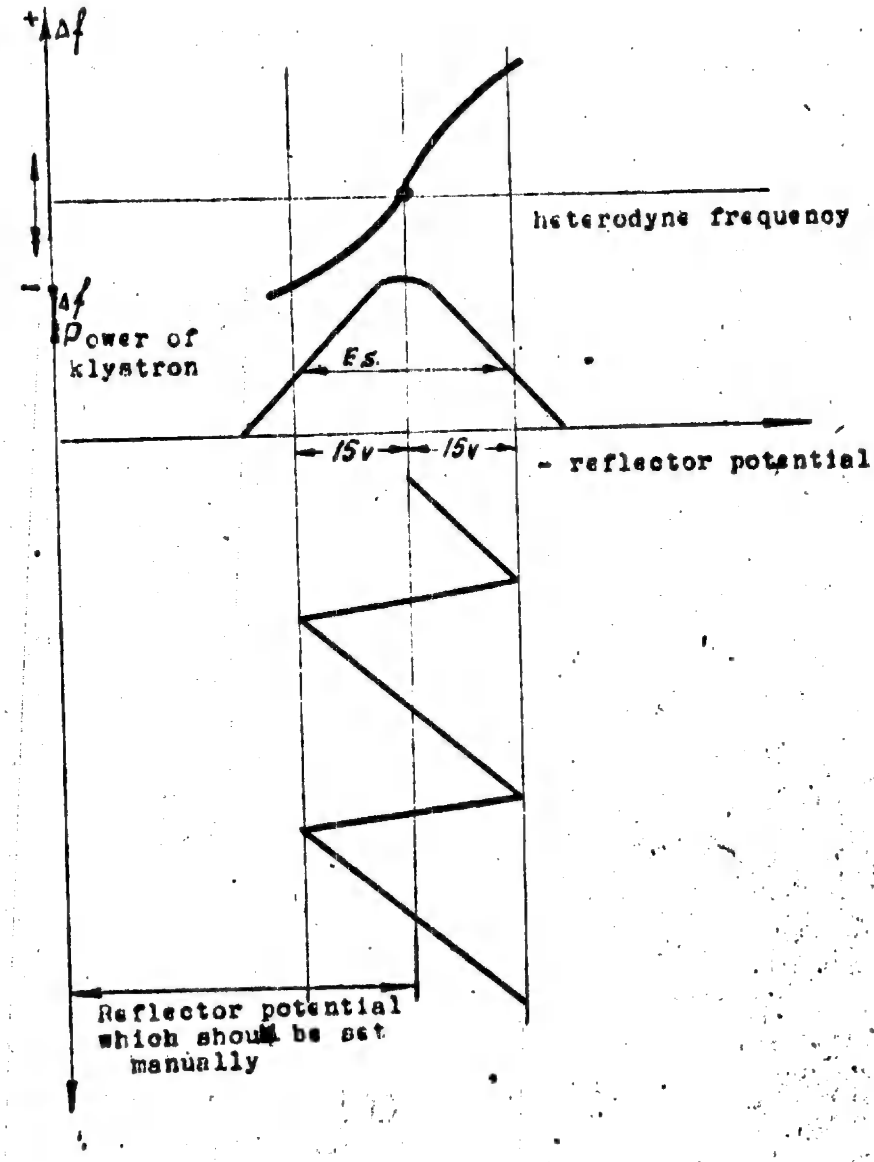
+Δf
heterodyne frequency
-Δf
Power of klystron
Es.
15v
15v
- reflector potential
Reflector potential which should be set manually

Fig. N 25

and transitron generator operates in regime of nature oscillation. In this regime a sowtooth voltage goes to klystron reflector. D.c. negative voltage also goes to the reflector from the voltage divider, i.e. there are the sowtooth and d.c. voltages on the reflector. The klystron oscillation frequency depends on the reflector voltage, and the sowtooth sweeps the klystron frequency in limits, which are determined by the sowtooth amplitude and the electron tuning range. Intermediate frequency will be sweeped with the klystron frequency sweeping. Fig. N 25 shows the dependence of the klystron frequency and power on reflector voltage and sowtooth.

Automatic control regime

The A.F.C. sweeps klystron frequency till the intermediate frequency becomes lower than 41 Mc. At the moment discriminator output pulses take negative value. The discriminator output negative pulses stop transitron nature oscillation and change it in d.c. amplifier regime. At the moment A.F.C. regime starts. If intermediate frequency is decreased by means of random fluctuations of signal or heterodyne frequency, the transitron output negative voltage will decrease. In accordance with it the heterodyne frequency will decrease and the intermediate frequency will increase. In the case of I.F. increasing the negative voltage ... will also increase, and it will result an increase of the

transitron output negative voltage and, in accordance, an decrease of intermediate frequency. Discriminator output pulse amplitude depends on I.F. deviation. If the intermediate frequency increases suddenly or decreases to a degree, the discriminator output pulses will take positive value or disappear. The A.F.C. will be returned again in the searching regime and the sowtooth voltage will be applied again to the klystron reflector. The sowtooth will "sweep" the heterodyne frequency in broad range and accordingly will sweep the intermediate frequency. In sweeping, the intermediate frequency will pass the value, at which the discriminator output negative pulses will be produced. After the discriminator output negative pulses reach a level enough to stop the nature oscillation of transitron, the A.F.C. circuit will change in automatical control of the klystron frequency regime.

Error-signal channel

The first 4-stage I.F. amplifier is common for error-signal and A.F.C. channels. After 4-th stage I.F.pulses, modulated with frequency "W", are going to error-signal detector. From detector load the pulses are going to I.F. band-elimination filter. After I.F. suppression amplitude modulated video-pulses are amplified in 2-stage

video-amplifier and through the cathode follower are going to the error-signal separation device (to socket N 27 of the K1-6M unit). Pulse middle level is remained constant by means of A.G.C. The video-pulse envelope amplitude is proportional to the input pulses percentage modulation.

A. G. C.

There is delaied and amplified A.G.C. circuit. Error-signal video amplifier is an element of A.G.C. circuit. Filter A.G.C. time constant is suited to suppress the error-signal component "D" in A.G.C. voltage composition. So, A.G.C. reacts only on comparatively slow fluctuations of the input signal power.

Synchronization channel

The I.F. pulses from mixer, are amplified by four I.F. stages. The I.F. amplifier output signal is led to second detector input. The detector load negative video-pulse is led to the 4-stage video-amplifier. Synchronization output video-pulses are not to be amplitude modulated, so video-amplification stages should operated in clipping regime.

Last stage output video-pulses through cathode synchronizes the natural oscillation blocking-

Blocking-generator eliminates the residual amplitude modulation of clipping pulses. It produces the synchronization pulses, shape and amplitude of which do not depend on the input pulse form and amplitude. The pulses are led ~~xx~~ to unit KI-6M socket N 26.

§ 5. Autopilot control unit KI-6M

Unit circuit may be functionally divided into four parts:

I. Reference separation channel, consisting of:

1. "single stroke" blocking-generator - Л I (left half);
2. detector - Л I (right half);
3. amplifier - Л 2;
4. phaseshifter - Л 3 (left half);
5. phasesplitter - Л 3 (right half);

II. Error-signal separation channel, consisting of:

1. "A" third detector and A.G.C. - Л 9;
2. "B" third detector and A.G.C. - Л 8;
3. Selective amplifier - Л 10 and Л II (left half);
4. Paraphase amplifier - Л 12 (right half);
5. Cathode follower - Л II (right half);

III. "Y" and "Z" driving voltage channel, consisting of:

1. reference voltage amplifier - Л 4 (left half) and Л 13 (left half);

25X1

2. two paraphase amplifiers - Л4 (right half) and Л13 (right half);
3. two clipping amplifiers - Л5 and Л14;
4. two phase detectors - Л6, Л7, Л15 and Л16;
5. two power amplifier - Л17, Л18, Л19 and Л20.

IV. Time motor, consisting of:

I. motor Д 5-ТР;
2. reducer;
3. cam contactor;
4. range potentiometer.

I. Reference voltage separation channel

The channel is intended for reference voltage separation from recurrence frequency modulated pulses and for producing of second reference voltage, which should be phase-shifted by 90° relative to first reference voltage. It is intended for giving away the synchronizing pulses too. Recurrence frequency modulated pulses are led to the socket N 26 from the unit KI-5MP synchronization channel output.

The pulses trigger the "single stroke" blocking-

S-E-C-R-E-T

25X1

generator, which maintains recurrence frequency [illegible] and constant shape and amplitude of pulses.

Blocking-generator cathode load positive video-pulses are led to socket N 25 to synchronise the KI-9M unit and to socket N 28 to synchronise the KI-12MP unit. Besides the pulses are applied to the detector, which detects frequency "Ю" sinusoidal voltage from reccurence frequency modulated pulses. The detected voltages are led through the filter to the amplifier. After filtering and amplification the voltage is applied to the phase-shifter. The plaseshifter output voltage portion goes to the error-signal channel to compensate the reccurence frequency modulation influence on error-signal value.

The phaseshifter is provided for initial phase [illegible] setting between the reference voltage and the error-signal.

The correctly phased unit must produce channel "Z" output voltage and channel "Y" zero output voltage, when the reccurence frequency modulation is in phase with the reference voltage. Then the reference voltage is led to the phasesplitter.

Two phasesplitter output orthogonal sine reference voltages (R.V.0° and R.V. 90°) are applied to the "A-B" regime relay. In regime "A" the voltages go to the course and elevation driving voltage channel through normally closed contacts of the relay P-I,

Regime "B" reference voltages are two orthogonal sine frequency " Я " voltages, which are led from the unit KI-7M reference generator, In regime "B" the "P-I" relay is switching on the reference voltages to the driving voltage channel input. In this case, the regime "A" reference channel does not operate, excepting the blocking-generator, which gives away synchronization pulses.

II. Error-signal channel

The unit "KI-5MP" (socket N 27) and the unit "KI-8M" (socket N 24) output A.M. pulses are applied to "A" detector and "B" detector, accordingly. The detectors separate out the error-signals, values of which are proportional to A.M. percentage of input pulses. The error-signal goes to the selective amplifier input through relay "P-I" contacts. In "A" regime the relay "P-I" winding is currentless and amplifier is tuned at "Ю" frequency.

When swiched on "B" regime +27 voltage is applied to the relay "P-I" winding, the selective amplifier is retuned at " Я " frequency and "B" detector output error-signal is given to the amplifier input. Selective amplifier output error-signal is led to the paraphase amplifier. Two antiphase voltages from the amplifier plate and cathode are given to grids of driving voltage channel "Y" and "Z" phase detectors.

Besides paraphase amplifier output voltage portion is led through the cathode follower to the "KI-I2MP" unit (tracking beacon signal).

III. Course driving voltage channel ("Y" channel)

The 0^{o} reference voltage goes through normally closed contacts and is applied to the paraphase amplifier input, from which two antiphase voltages go to the limiting amplifiers. In the amplifiers the sinusoidal voltages are transformed into square wave voltages. The square waves feed phase detector tube plates.

Error-signal antiphase voltages are applied to the phase detector grids. The value and polarity of the phase detecter output pulsating volatge d.c. component depend on error-signal amplitude and phase shift between the error-signal and "0^{o}" reference voltages. The pulsating voltage is filtered and applied to the power amplifier input. Power amplifier output d.c. voltage goes through distribution box (KI-I3M) to the autopilot.

IV. Elevation driving voltage channel ("Z") channel)

"Z" channel is completely analogous to the "Y" channel. Since 90^{o} reference voltage is applied in this case, the channel output driving voltage will depend on error-signal amplitude and phase shift between error-signal and

90° reference voltage.

V. Time motor

The time motor varies the error-signal channel amplification in "A" regime from the moment of the drop-command. The amplification-time function is programmed by range potentiometer winding. In addition the time motor produces the command N I, command N 2 unblocking voltage and signal of start and end time motor position.

§ 6. "B" antenna - "KI-7M" unit

The unit has the following functions:

I. picks up the echo-signal and amplitude modulate them with scanning frequency " Я ".

2. Makes two orthogonal frequency " Я " sine voltages, which are phase shifted against each other by 90° (reference voltages).

3. Channels the U.H.F. modulated signal to the unit KI-4bM input.

§ 7. KI-5 M Unit

The unit carries out mixing of echo-signal with klystron signal, producing the frequency combination signals and channeling it to the unit KI-8M input.

§ 8. "B" receiver K1-8M Unit

The unit circuit may be devided into three parts:

- error-signal pulse channel for K1-6M unit,
- echo-signal pulse channel for K1-9M unit,
- A.G.C. channel.

The unit consists of:

1. I.F. preamplifier - tubes Л1 and Л2;
2. I.F. amplifier - tubes Л3, Л4, Л5, Л6, and Л7;
3. Second detector - tube Л8;
4. Video-amplifier - tubes Л9 and Л10;
5. Cathode follower - tube Л11 (right half);
6. Video-amplifier - tube Л11 (left half) and Л13 (right half);
7. Cathode follower - tube Л13 (left half);
8. A.G.C. detector - tube Л12 (right half);
9. A.G.C. cathode follower - tube Л12 (left half).

Amplitude modulated with " Я " frequency I.F. pulses go to two-starge pre-amplifier input through the socket Ш 34. After pre-amplification the I.F. pulses go to 5-stage I.F. amplifier. I.F. continuous tunning is carried out by the unit K1-5MP ЖX A.F.C.

After main I.F. amplification the pulses go to the second detector Л8. After detection A.M. video-pulses are amplified in two-stage video-amplifier and through the cathode follower (Л11 right half) are led to output Ф 24.

The cathode follower output video-pulse modulation percentage is equal to the unit input I.F. pulse modulation percentage.

In operating range the average signal level is maintained constant by means of the A.G.C. For the receiver blacking out the I47v bias is applied to the 5-th I.F. stage. The bias is taken away only after command N 2 unlocking. After unlocking the receiver is blacked out by stable negative bias, applied to priming and pentode grids. The receiver is opened only in the strobe moment. If the toggle switch "strobe - +" is in the position "+", the bias +I30v is applied to 5.th I.F. stage. In this case the receiver is opened always and does not depend on strobbing.

From the cathode follower ЛII (right half) video-pulses go to the echo-signal channel video- amplifier, consisting of two stages ЛII (left half) and ЛI3 (right half), and to the A.G.C. detector ЛI2 (right half). Amplified positive video-pulses are given to unit output socket "Ф23" through cathode followerЛI3 (left half). The ЛI2 tube plate (right half) negative voltage biases first 4 stage control grids of the main I.F. amplifier. For manual gain control the negative voltage is led to the A.G.C. circuit and controlled by the "M.G.C." potentiometer,which is installed on the unit front panel.

§ 9. Range unit (or autoselector) K1-9M

The unit circuit may be devided into two main parts:

I. Search and track device, consisting of:

1) buffer - Л9 (left half);
2) multivibrator - Л10;
3) differentiated pulse amplifier - Л9 (right half);
4) buffer - Л11;
5) strobe blocking-generator and cathode follower - Л13;
6) half-strobe blocking-generator and cathode follower - Л12;
7) two coincidence cascades - Л4 and Л5;
8) difference detector and cathode follower - Л3 and Л2 (right half);
9) search starting tube - Л2 (left half).

II. Command N 2 producing device, consisting of:

1) coincidence detector - Л14 (left half);
2) clipping diode - Л14 (right half);
3) electron relay - tube Л15 and relays P1, P2, P3.

Searching and tracking device. Synchronization positive pulses are given to the unit input socket N 25 from the K1-6M ~~[illegible]~~ unit. Through buffer the pulses trigger the "single stroke" multivibrator (Л10). Each synchronisation pulse triggers the positive variable pulse. The

pulse length is 120 ± 17 μsec in searching regime and 120 ± 1,6 μsec in tracking regime. The pulse length is determined by multivibrator grid bias, which is led from cathode follower Л2 (right half) and from voltage divider.

Searching regime multivibrator grid bias is the clipping and biassing sawtooth (see fig.N 26).

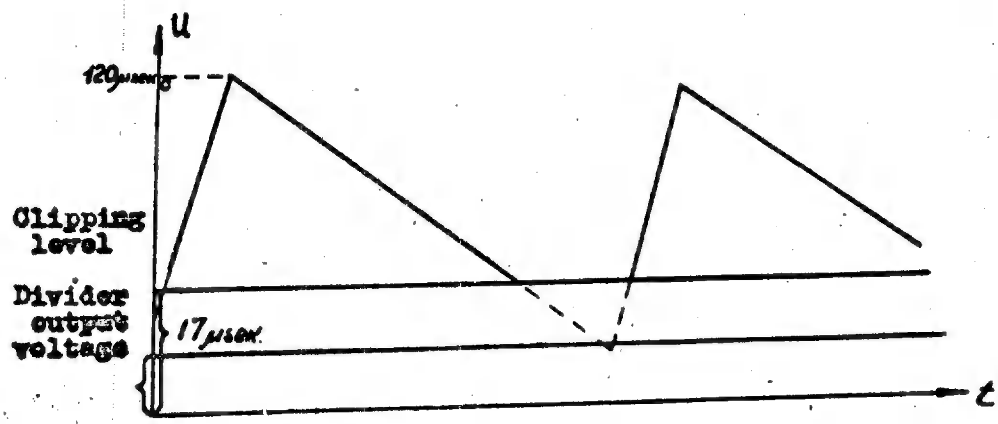

Fig.26. Searching regime cathode Л2 sawtooth

Sawtooth voltage is produced by controlling stage, which is a tranzitron in searching regime. The below clipping of sawtooth is provided by search starting tube Л2.

The search starting tube (Л2 left half) and cathode follo-

wer (Л6 right half) have the common load. The slow dropping sawtooth is applied at the search starting tube grid. The Л2 cathode positive voltage follows the sawtooth form. The Л 6 tube, cut off by that positive voltage, will be open, when cathode and grid potentional will be approximately equal. When Л 6 tube will open, the Л 2 tube will be cut off by means of cathode load dropping and M.V. grid voltage will became constant, and accordingly multivibrator pulse length will became constant.

Constant voltage value, determined by divider position, may to vary the max and min levels of multivibrator grid sawtooth and accordingly to vary the multivibrator output pulse length from max to min value. Besides that, the multivibrator output pulse length may be varied by "search starting" potentiometer tuning, which regulate the trigger level of Л 6 tube (right half). The multivibrator variable pulses are going to the differentiating circuit and then to the amplifier. The positive pulses, coinciding with M.V. pulse front, are surpressed by means of the amplifier zero bias grid current. The amplifier output pulses, coinciding with the M.V. pulse rear edge, trigger the strobe and half-strobe blocking-generators.

The strobe blocking-generator produces the strobe-pulses with 80v ÷ 130 v amplitude and length approximate 2 μsec. The halfstrobe blocking-generator output pulses have amplitude 100 v ÷ 130 v and pulse length approximately 0.

Since the strobe and half-strobe pulses are tied to M.V. pulse rear edge, the pulses will be variable delayed relative to the trigger pulse within the limits of 120 μsec to 17 μsec in searching regime. The half-strobe blocking generator output pulses go to coincidence cascades through the cathode followers:

The first one - to I-st coincidence cascade pentode grid and

the second one - to 2-nd coincidence cascade pentode grid through the delay-line (0,8 μsec).

The strobe-pulses are led through cathode follower Л13 (left half) to the KI-8M unit socket N 22. Besides the strobes are led to the command N 2 circuit.

When the echo-signal is applied to the unblocking and strobbing receiver input the positive video-pulse coinciding with strobe is going to the unit KI-9M input through the socket "Ф 23".

The video-pulses are applied to I-st and 2-nd coincidence cascades of the time discriminator and to the Command N 2 coincidence detector. The coincidence cascades are normally cut out by the control and pentode grid biasing. The nondelayed half-strobe is applied to the first coincidence stage pentode grid and the delayed half-strobe is applied to the second coincidence stage pentode grid. The echo-signal pulse is applied at the control grids of two coincidence stages. Let us examine the case when echo-pulse and nondelayed half-strobe coincide in time. In this case the first coincidence stage opens and the negative pulse is

produced at its plate. The pulse length depends on the overlapping area of echo-pulse and half-strobe. The pulse amplitude depends on the echo-pulse amplitude. The output pulse is applied to the right cathode of difference detector and cuts in the latter.

The charging circuit of the accumulator capacitor is cut in. The accumulator capacitor voltage increases and transitron control grid voltage also increases. As a result, the sowtooth steepness and accordingly the half-strobe speed will increase too. In the next moment the echo-signal will coincide with delayed half-strobe due to the half-strobe movement. In the coincidence moment the second stage cuts in and produces a plate negative pulse. The pulse provides negative charging of the accumulator capacitor "C5", and stopping of the control stage oscillation (i.e. transferring to the plate-grid coupled integrator regime) and, besides, reversing of half-strobe movement. As a result of the half-strobe reversing, some time latter the echo-pulse will occupy approximately symmetrical position between half-strobes. In that moment accumulator capacitor voltage will be near equal to zero.

From the moment, tracking echo-signal regime starts. If the echo-signal delay changes the half-strobes track the echo-signal due to control voltage changing, which through the controlling stage and the cathode follo-

wer is applied to controll grid of the multivibrator. Since the strobe and half-strobe pulses are synchronous, the strobe will open the receiver in the moment of echo-signal arrival. If an echo-signal level is high enough, command N 2 is produced after a target locking on (i.e. coincide stages cutting in).

For lower tracking range boundary reducing, command N 2 lock on the tube "Л6" by means of relay "P4". With that the lower boundary of echo-signal tracking range decreases from 17 μ sec to 1.6 μ sec, because the transitron sawtooth is not clipping.

Command N 2 device is provided to produce and give away the command N 2 and to obtain the command N 2 switching off time delay.

The device consist of:

- coincidence detector Л14 (left half),
- clipping diode Л14 (right half),
- electron relay Л15, P2 and P1.

The detector is normally blocked. When the strobe applied to plate Л14, and an echo-signal, applied to the control grid of Л14 are coincided (i.e. the target is locked on), the detector becomes unblocked and the negative voltage will apply to the electron relay control grid. This tube is normally unblocked, i.e. plate current is flowing through relay P-2 winding. The detector output negative voltage blocks the relay tube. Relay winding current is died and the relay operates.

As a result of relay switching the additional capacitor C53 will be connected in parallel with accumulator capacitor and feeding circuit of relay P-I; P-2 will be disconnected. The relay P4 contacts N 1 and N 2 close and ground the "search starting potentiometer" slider. The tube 6 will be blocked and the M.V. grid voltage will be the "sowtooth" without clipping from below".

The relay PI initiates the command N 2 (+27v) and transmits it to the external circuits.

For tracking echo-pulse by the strobe when echo-pulses are abruplty diminished a "memory" in the Command N 2 circuit (time delay of the command N 2 switching off) is provided. So, in echo-pulse diminishing the strobe delay time speed is kept constant during 3 sec. by means of large time constant of the coincidence detector RC circuit. On account of that, the command N 2 switching off (relay P2 operation) is realized only 2.5 + 3.5 sec after echo-pulse diminishing. The relay releasing time independence on echo-pulse amplitude is provided by the clipping stage, which maintains voltage of the relay grids approximately constant.

§ IO. Tracking beacon responder "KI-I2 MP"

The unit consists of:

I. Triggering pulse amplifier 2 (left half);

2. Multivibrator I;

3. Differentiated pulse amplifier Л2 (right half);
4. Blocking-generator Л3;
5. Power blocking-generator Л4;
6. U.H.F. generator Л5.

A possibility of the generator tube aging is provided. The unit K1-6M output positive triggering pulses are led to socket N 28. The pulses trigger the delay multivibrator through the amplifier.
The multivibrator produces positive rectangular pulses which last 170±10μ sec. After differentiating the pulses are led to the amplifier of differentiated pulses. When the unit K1-6M output frequency "0" error-signal is injected to the unit K1-12MP, multivibrator rectangular pulse length varies depending on the error-signal amplitude.

When the command N 2 (+27v) is applied to the cathode of a "single stroke" multivibrator, the multivibrator will be transfered to an amplification regime. The M.V. output pulse length becomes equal to 1 μ sec, approximately. After amplification the pulse, coinciding with the M.V. pulse front, is clipped while the pulse, coinciding with the M.V. pulse edge, triggers the blocking-generator, which produces positive pulses for triggering power blocking-generator. The power blocking-generator ("modulator") feeds the U.H.F. generator plate by rectangular pulses. [illegible] pulses of the U.H.F. generator feeds the antenna

K1-11 through the cable N 31 and radiated in the mothership direction.

The U.H.F. output pulses are delyed relatively the unit K1-6M triggering pulses by the time $170 \pm 10 \mu$ sec, when the "M" voltage is absent at the multivibrator input.
In "B" regime the pulses are transmitted aproximately simultaneously with the unit K1-6M triggering pulses, the initial time delay is less than 10 sec.

Cable assembly

The cable assembly consists of eight coaxial cables NN 22, 23, 24, 25, 26, 27, 28, 31 and one multiconductor cable N 15.

The cables are provided for:

- cable N 22 connects K1-9M unit and K1-8M unit,
- cable N 23 connects K1-8M unit and K1-9M unit,
- cable N 24 connects K1-8M unit and K1-6M unit,
- cable N 25 connects K1-6M unit and K1-9M unit,
- cable N 26 connects K1-5MP unit and K1-6M unit,
- cable N 27 connects K1-5MP unit and K1-6M unit,
- cable N 28, consisting of two parts: 28/1 and 28/2, connects K1-6M unit and K1-12MP unit,
- cable N 31 connects K1-12MP unit and K1-11 unit,
- multiconductor cable N 15, consisting of two parts: 15/1 and 15/2, connects K1-12MP unit and K1-13M distribution box.

CHAPTER V

DESCRIPTION OF THE ELEMENTARY DIAGRAM OF THE RADAR K-1M UNITS

§ 1. Description of the unit K1-1M

The antenna is a dielectric rod, jutting out the round waveguide. The rod serves for forming of the antenna radiation pattern.

The half power level beamwidth is 30°.

The rod cross-section increases gradually approaching to the waveguide. It's necessary to providd the matching between space and waveguide input impedance. The dielectric rod is threaded and screwed in the round waveguide.

The rod tail transforms the circular polarization wave into the H_{11} mode of wave of linear polarization, which is transformed into the H_{01} mode wave in the rectangular waveguide.

The rotating field frequency is equal to the radiation frequency.

The circular polarization field vector may be represented in form of, two linear polarization components, which are amplitude equal and 90° - phaseshifted in space and time.

The spatial phaseshift is provided due to the fact wave H_{11} polarization plane. Thanks to the fact, two linear polarized and spatial 90° phaseshifted waves are created.

The amplitude equality is provided when the angle between tail and mode H_{11} field vector is equal to 45° aproximately. The time phaseshift is provided by difference between the component propagation speed, which is conditioned by nonidentical propagation of the components. A wave propagation speed in dielectric is less than one in free space; so there will take place 90°-phaseshift at the certain value of the tail length.

Equality of the component amplitudes is reached by turning the tail.

So, the antenna makes possible U.H.F. wave reception, when electrical fild vector is oriented on any plane.

The waveguide adapter transforms the H_{11} mode wave into the H_{01} mode wave.

Description of the unit K1-3M

The full unit K1-3M description is given in the chapter IV "Radar K-1M skeleton Diagram".

§ 2. Unit K1-4aM Elementary Diagram.

a) Mixer.

The mixer is manufactured ~~as~~ of an antiphased directional coupler, which consists from two waveguides soldered by broc side and narrow one, and a crystal holder for the DK-C4 crystal.

The antiphase directional coupler changes the propagation direction of the U.H.F. wave, going from one waveguide to another.

In that way, the heterodyne signal goes to the crystal mixer. Some portion of the heterodyne energy which is not passed through directional coupler holes to the mixer is absorbed by matched load, that is placed in the dead end of the lower waveguide. An input signal also goes to the crystal mixer. The crystal holder and cable capacitance as well as the input inductance form the resonance circuit, tuned at 40 Mc approximately.

The crystal mixes the input signal and the heterodyne signal and gives away the combination frequencies to the unit K1-5MP input.

The unit K1-5MP input circuit separates the intermediate frequency.

The antiphased directional coupler provides decoupling between signal and heterodyne circuits. The decoupling is carried out by a changing the propagation direction and absorbing the energy, which passes through directional coupler holes, by lower waveguide matching load. The 10 ÷ 17 db attenuation of heterodyne power, which goes to crystal mixes is provided due to the crosstalk attenuation. The crystal holder is a socket, into which crystal-plug with crystal is inserted. By moving and turning the crystal the tuning at lower standing wave ratio is carried out.

There is provided the best uncoupling and the least input signal power loss. The crystal - plug position is fixed with a nut screwed on the socket. From behind of the crystal the metal end cap is set. The end cap position variance makes possible the reducing of the standing wave ratio up to necessary value.

b) Klystron section

The klystron section is made as a "Magic T" (twin triplet). The Magic T is the junction of equal cross-section wave-guide bits, which is shown in the fig.N 27. It consists of the E-plane T-junction and H-plane T-junction.

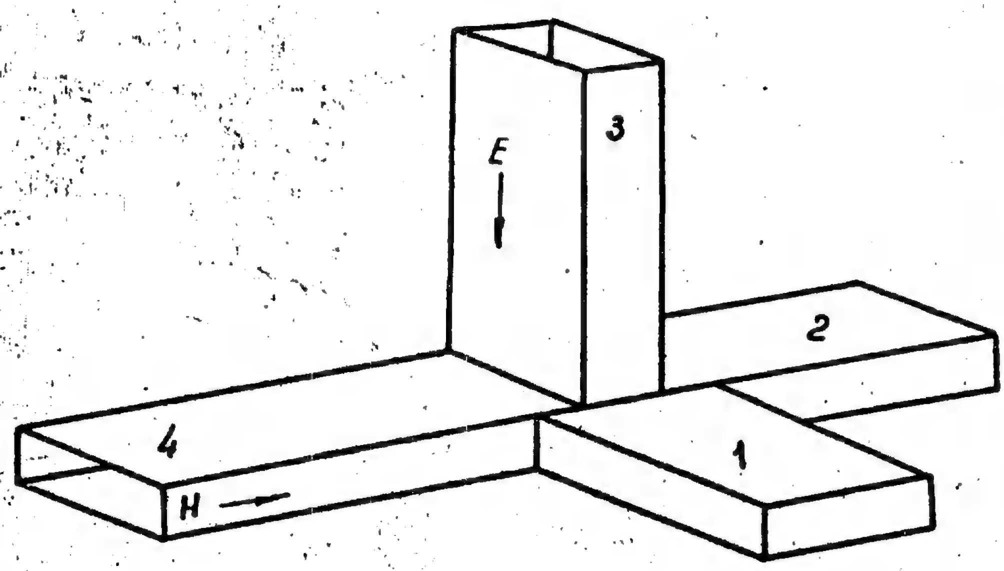

Fig.N 27

The matched twin triplet has the following property: U.H.F. energy donnot pass from the even arm to other even one and from the odd arm to other odd one, but it passes freely from the even arm to the odd arms and from the odd arm to the even arms (see.fig.N27). This property provides the uncoupling between the mixer arms NN 2 and 4 and provides also the heterodyne power equal dividing between arms N 2 and N 4. For triplet matching there is the arm N 1 absorbing load, which is made as a hetinax taper installed in the wavequide. The taper donnot intake the klystron energy in correspondence with the triplet property. The iris, the screw and the arm N 3 plunger serve as twin triplet tuners. By means of the iris and the screw a matching between the triplet and the arem N 3 is carried out. The plunger is provided for matching the klystron with the arm N 3 wavequide. The plunger tunes the heterodyne U.H.F. power output to arms NN 2 and 4 and is fastened in a position corresponding to max. heterodyne power output. The variable attenuators are in the side arms N 2 and N 4, which are connected with the "A" and "B" mixers. The attenuators adjust heterodyne power value, applied to the mixer (i.e. quiescent point of crystal is determined). The klystron holder is installed in the arm N 3. The heterodyne is the reflex klystron "K-38", to which cavity the +300 v is applied. The A.F.C. negative voltage of unit K1-5MP is applied to the reflector of the klystron. The variel

attenuator is also placed in the arm N 3, and adjusts the klystron power value, applied to the mixer crystals.

The antiphased directional coupler is installed on the broad side of the klystron arm N 3. Due to the fact the heterodyne energy is led partly to the coupler and so the klystron power monitoring is provided. The antiphased [illegible] coupler output is covered by a cap.

§ 3. The unit KI-4bM elementary diagram

The "B" antenna KI-7M output U.H.F. signal is led to the unit KI-4bM crystal mixer. The unit KI-4aM klystron signal is led to the mixer through antiphased directional coupler. The mixer output signal is led to the unit KI-5M input, where the intermediate signal is selected by the unput circuit.

§ 4. The unit KI-5MP elementary diagram

The crystal mixer output I.F. signal is led to the unit KI-5MP input through the cable N 30.

I. The unit circuit

The unit input network is the band-pass filter (a kind of transformer-coupled circuit). The primary of cir[illegible] is formed by the inductance LI, the crystal mixer cap[illegible]citance, the connection cable capacitance and the stray capacitance. The inductance L2 with the grid circuit stray capacitance and tube ЛI input capacit[illegible]

the secondary circuit. The secondary I.F. signal is applied to the control grid of I.F. amplifier Л1. The input circuit bandwidth is approximately 10 ÷ 16 Mc. The resister RI is provided for the crystal current constant component.

2. The A.F.C. channel

a) I.F. amplifier

The A.F.C. channel I.F. amplifier consists of five 6Ж1П stages. The first two are single tuned to 40 Mc stages, and the next three stages are stagger tuned:

the circuit L5 f = to 41 Mc
the circuit L6 f = to 39 Mc
the circuit L7 f = to 40.5 Mc.

The resistors R2, R5, R10, R14, R16 and R20 provides the circuits essential bandwidth by shunting of circuits. R3, R6, R7, RII, R15 and R19 are the stage cathode bypass resisters.

The pentode input capacitance is determined by interelectrode capacitance and a capacitance component, depending from an electron flow, by-passing the control grid. The component is the function of a tube transconductance. The tube transconductance variance changes the tube input capacitance and, accordingly with that, the preface circuit tuning. Since the unit KI-5МР I.F. amplification is controlled by the transconductance variance of the first tubes, the I.F. amplifier frequency-response curve middle will be also varied. To exclude the

transconductance t tube input capacitence dependance, the cathode resistor do not shunt by a capacitor partially or totally. Since the unshunting cathode resistor a.c. component plate current drop voltage is applied to the tube input, the tube input impedance varyes in dependance of the its transconductance. The tube input capacitance may be done undependent from the transconductance by matching of an unshunting resistor value. For this purpose the resistor R6 is at the tube Л2 cathode and it provides the negative feed/back, which is necessary for I-F-frequency respose stability, when the gain is varying by means of A.G.C. variable voltage. The capacitors C6, CII, C16, C21, C26 are the bridging capacitors of the tubes. The capacitors C9, C14, C19, C24, C30 are the interstage transit capacitors. The resistors R9, R13, R17, R21, R22, R28 and the capacitors C8, C13, C18, C23, C28, C33 are the tube plate power supply filters. The tube filament power supply filters are formed by the chockes L14, L15, L16 and the capacitors C7, C15, C25, C31.

The resistor R27 determines the first stage operation regime and with capacitor C20 forms the screen grid power supply filter. This filter is necessary becaurse, when the unit and Radar are checking, the modulated sine frequency "10" voltage should be applied to the first stage screen grid through the capacitor C96. The additional A.G.C. negative bias is applied to the grid of the first 4 I.F. stages through the uncoupling circuits: R4, R5, R8, R12, C17 and C22.

The tube 6 stage is the I.F. amplifier...

in clipping regime for excluding the " " frequency amplitude modulation of the input pulses. The Stage regime differs from the other stage regime by absence of bias and the screen grid voltage which is determines by the resistors R24 and R25. The capacitor C32 is filter capacitance. The stage frequency responce is determined by circuit L8, tuning at 40 Mc, and discriminator circuit.

The I.F. pulses are led to the discriminator through the capacitor C34. To take from the discriminator output the max. pulse amplitude, the I.F. signal is tapped from I/3 part of the coil L8. The tube 6X4П (Л 7) discriminator is made as a balancing network with the series frequency circuits.

The circuit, consisting of the inductance L9, the diode input capacitance, capacitors C36 and C38 and the stray capacitance, is tuned at 38.8 Mc. The secondary circuit L10 is performed similar to the primary and tuned at 42.8 Mc. The bandwidth of the circuits is within 5-6 Mc.

The I.F. amplitude clipped pulses are led to discriminator from the latter I.F. amplifier. The right half Л 7 plate or left half Л 7 cathode voltage value depends on the input signal deviation from a conformable circuit resonant frequency.

The voltage value will be larger in the circuit, which resonant frequency is nearer to an input signal frequency. The capacitors C38 and C39 are charged in the signal coming moment. The capacitor C38 "+" or "-" polarity charge network is: the left half tube Л 7 plate, the choke L9

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and LII, ground the capacitor. The capacitor C39 charging network is: the tube Л7 right plate, the capacitor C39, ground, the chokes LII and LIO. In the intervals between input signals the capacitors will be discharged through the resistors R30 and R29 (discriminator load). The difference between the R30 voltage drop and the R29 voltage drop is an output signal of the discriminator. The output signal polarity is dependent on a sign of a signal frequency deviation from the I.F. value. The A.F.C. operation point is matched so that negative discriminator output video-pulses are used only. The pulse length is approximately 25 μ sec.

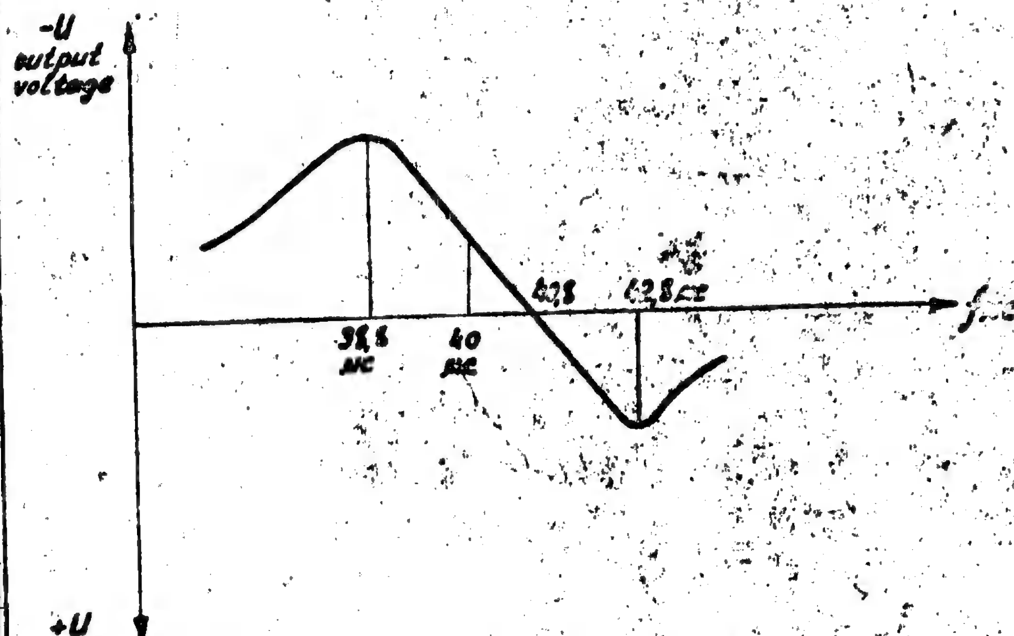

Fig.N 28. The discriminator responce.

To exclude 400c stray induction, the discriminator tube filament is biased by +25v relative to the cathode. The later is taken from the divider R90, R91. The capacitor C77 is high frequency by-passing capacitor. A discriminator current d.c. component by-passing network and next stage grid-leak are the choke LII. The capacitor C42 increases the A.F.C. operational stability.

The discriminator output negative pulses are taken from the load center point (between R29 and R30) and led to the video-amplifier Л8 (left half) input. The amplified positive pulses through the transit network C40, R34 are led to the cathode follower " Л8 (right half) grid and to the monitoring jack "Г7" ,which is provided for the discriminator responce monitoring. The cathode follower output video-pulses through the capasitor C4I are led to the rectification diode Л9 (left galf) and to the monitoring jack " Г I" (c.follower A.F.C.).The rectified positive voltage from the diode load R35 is led to the tube ЛI0. When positive pulse is at the tube Л8 cathode, the capacitor C4I is charging quickly through the diode and than it's discharging slowly through resistor R35.

The discharging time constant is adjusted so, that the capacitor is not discharging during time intervals between the pulses. So the negative aproximately constant voltage is obtained at the diode load. The voltage value depended upon an amplitude of the pulses led from the tube "Л8" cathode. When a negative voltage less than 4v is applied to the tube " ЛI0" control grid, the tube

S-E-C-R-E-T

operates as a transitron. If the tube ДIO control grid bias is larger than 4v, the sowtooth generation is stopped and the tube became to operate as a d.c. amplifier.

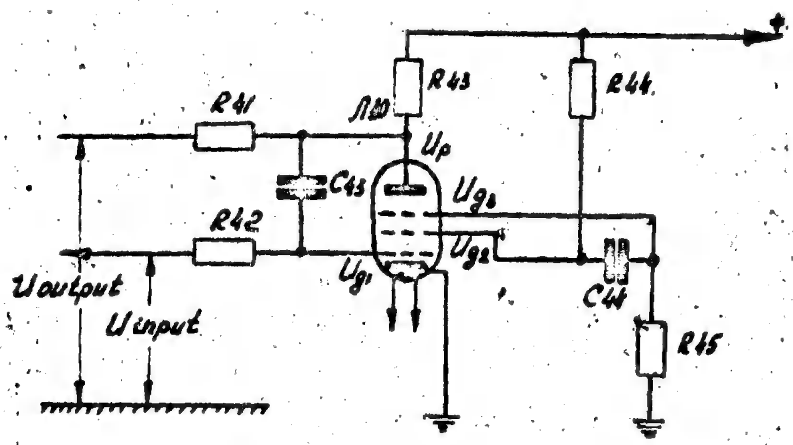

Fig.N 29. The transitron circuit.

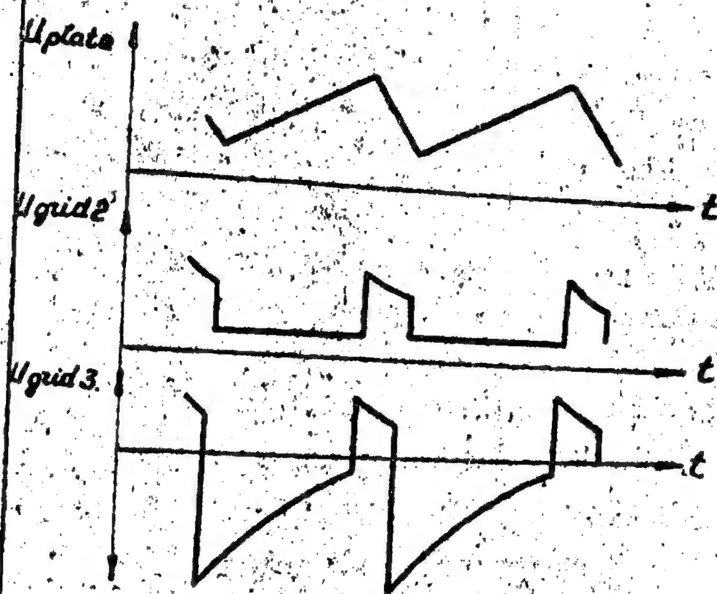

Fig. 30. The transitron time correlations.

Let us to examine the circuit operation. The transitron operation principle is determined by a distribution of a pentode tube current in the dependence of a pentode grid potential between a plate and a screen grid. If a pentode grid voltage decreases and becomes negative one, the plate current also decreases and may be zero, since the screen grid current increases up to the max.value. In the opposite position all will be in reverse succession. I.e. the pentode grid serves as a control electrode and distributes the cathode current between the plate and the screen grid.

The positive feedback between the screen and pentode grids through C44 is ample for circuit regeneration, when the control grid negative bias is less than -4v.

So if the pentode grid voltage is positive the current goes to plate. When a negative bias is applied to control grid, the dynamic equilibria of the circuit is broken out. Charged before C44 became to discharge through the screen-cathode space and resistor R45 and make across R55 a voltage dropping, which applies between the pentode grid and the cathode, biasing the grid (see fig.N 29).

The plate current is decreasing; this decreasing obtains the screen current increasing and a screen voltage dropping. After it is, the plate current will sharply increases up to zero. This process developes instantly till the plate current stops and the screen current became max. The pentode grid voltage became negative, since the screen voltage dropping is transmitted to the pentode grid through C44. Till the tube plate current cut off the C43 is charging. After some time a C44 discharging current decreases to a value, when a pentode grid voltage become sufficient for the plate current cutting on. The plate current became to increase, the screen current became to drop and, with it the screen voltage increases. This increasing by means of positive feed-back transmits to the pentode grid. The capacitor C44 became to charge. The positive (relative pentode grid) voltage, which is developed by the charging current across the R45, will increase the plate current

more and more. This process will continue till the plate current became equal to the max value and the screen current becames equal to zero or the least value. After that the oscillation cycle will repeating. The transitron oscillation period depends on the time constant of the C44 charge and discharge. If the control grid negative bias is more than 4 v. the positive pentode-screen feedback is not ample for regeneration and the circuit is switched in the stable regime of d.c. amplifier. The tube Л10 plate control voltage divides by R40 and R41 and is fed to the cathode follower Л9 (right half) grid. The cathode load R36 control voltage through the switch "B-I", cable and socket Ш 29 is fed to the klystron reflecter.

When A.F.C. operates, the klystron reflector constant voltage is adjusted by the potentiometer R38 ("A.F.C."). When switched on the manual tuning, the cathode follower output is cut off by the switch "B-I" and the reflector voltage is obtained from the potentiometer R46. The divider, consisting of R81, R93 and C35, furnishes the A.F.C. sufficient operating conditions.

3. The Synchronization Channel

The I.F. amplifier is common for the synchronization error-signal and A.F.C. channels. An I.F. output signal is applied to the error-signal diode detector Л12 (left half of 6Н1П). The diode has the cathode load R47, C29. The choke L17 is the I.F. filter. The positive detector output pulse is fed to the video-amplifier Л12

(right half) grid through C47. The negative video-amplifier output pulses are fed to synchronization video-amplifier (right half of Л17) grid through C5. The resistor-coupled triode "6HI " synchronisation video-amplifier has the 3 amplification stages. The positive first stage Л17 (right half) output pulse is fed to the second stage Л18 (left half) grid through the network C72, R80. The negative plate load R82 pulse is fed to the third stage Л18 (right half) grid through C73. The positive plate load R84 pulse, through the network C76, R87 is fed to the cathode-follower Л19 (left half) grid.

The cathode follower output pulse is fed to a winding of the pulse transformer and synchronizes the blocking-generator Л19 (right half). From the blocking-generator cathode load the video pulses are led to the socket N 26 and to the monitoring jack "Г-8".

The R78, R82 and C70, C74, C75 are the plate power-supply filters. The R94 and C97 are the plate power-supply filter of the cathode follower Л19. The R55 and C95 are the blocking-generator plate power-supply filter and obtains the blocking generator d.c. regime.

The resistors R65, R92, R62 and the capacitor C94 determines a blocking-generator nature oscillation frequency. By means of R65 the blocking-generator nature oscillation period may be set longer than "Ш" - period by 80-100 sec. The synchronisation channel output video-pulses should not be amplitude modulated, so video-amplifier stages operate in clipping regime. But clipping is not providing

an absolute absence of A.M., which is provided by means of output blocking-generator. The synchronization channel output pulses are positive, its amplitude is more than 60v and its length is aproxomately 1.5 μsec.

4. The error-signal channel

The error-signal I.F. amplifier is a part of A.F.C. channel (Л1, Л2, Л3, Л4); its gain is aproximately 300 and its bandwidth is no less than 4.2 Mc. From the inductance L6, the I.F. pulses are simultaneously fed to the tube Л5 grid (A.F.C. 5-th I.F. stage) and to the Л-12 left plate (error-signal video-detector). From detector cathode load R47 the positive pulses are led to the video-amplifier input and the jack "Г-6" through the I.F. filter L17 and capacitor C47. The first stage output video-pulses are fed to the second stage input through the network C53, R52. From the second stage plate load R69 the positive pulses go to the grid of the cathode follower Л11 (right half). The cathode load potentiometer R86 slider output positive pulse goes to the error-signal output socket № 27 and the monitoring jack "Г3" ("e.f.e.-signal"), Besides that the resistor R86 positive video-pulse is fed to the A.G.C. input (tube Л13).

The resistors R58, R53, R57 furnishes the cathode follower tube (Л11, right half) regime, and determines the A.G.C. delay voltage. The capacitors C49, C52 with these resistors are formed the power-supply filters.

5. The A.G.C. loop

The A.G.C. circuit is a kind of delayed and amplified one. The delay is carried out by means of applying the negative bias to the left half of tube Л13 grid from the voltage-divider network, formed by R53, R53 and R57. The delay voltage is so, that A.G.C. begins to operate when the U.H.F. mixer input signal power is approximately $5 \cdot 10^{-9}$ W. A rectified negative A.G.C. detector output voltage is fed to the control grids of the I.F. amplifiers Л1, Л2, Л3 and Л4 through the two-section filter formed by R63, R64, C92, C93. The jack "Г-4" provides the A.G.C. voltage monitoring.

The filter time constant is so that an error-signal frequency "Ω" component is excluded from the A.G.C. voltage. So, the A.G.C. circuit reacts only on a slow fluctuation of input signal average power. The A.G.C. voltage is applied to the I.F. amplifier control grids through the decoupling networks: R4, C56, R8, C12, C17, R12, C22. The left half of the tube Л13 is a cathode follower. From the middle point of the divider, formed by R60 and R51, the A.G.C. voltage is led to the monitoring board through the unit "KI-13I". When the receiver input signal are sharply increased, the left half of the tube Л7 operates as a diode clipping the A.G.C. overshootings. The essential clipping level is adjusted by means of R71.

6. The unit power supply

The d.c. power supply is carrying out by the unit KI-10I, which obtains the next voltages:

I. + I30v regulated,

2. + 300v unregulated,

3. - 300v regulated

4. - I47v regulated

The filament power supply is carrying out by II5 v 400c through the special transformer "Tp.-I", installed on the unit KI-5MP chassis. The all supply voltages are led into the unit by means of the cannon plug "Ш-7", through the filters, consisting of the chokes L26,L27,L28,L30,L24,L29 and capacitors C86, C89, C85, C84, C87, C80, C79, C8I and C78. The special winding is provided in the filament transformer for the feeding of the unit KI-4aM klystron filament. The klystron filament supply is led into the KI-4aM unit through the unit plug pins N 7 and N I3 and a special filters, consisting of chokes LI8, L33 and capacitors CI0, C27.

§ 5. The unit KI-6M elementary diagram

I. The channel of the reference voltage separation

The reference channel is provided for separation of the two 90° - shifted reference voltages from the A.M. input pulses. The positive synchronisation 0.5 ÷ I.5 μ sec pulses, modulated with percentage I.I% and frequency "40", are led through the socket N 26 from the KI-5MP unit. The pulses triggers the "single stroke" blocking-generator ЛI, which is normally cut off by means of a negative voltage from the divider RI, R2,

When the synchronization pulses go, the positive pulses are generated on the blocking-generator cathode load R4, R5. The amplitude 30÷60v pulses go from the resistor R5 to the socket N 25 and the jack Г-I. The amplitude 12÷40v pulses go through CI to the socket N 28. The blocking-generator cathode load full pulses go to the reference channel detector (Л I in diode connection), which detects the frequency "10" component from the amplitude modulated pulse train. This component is the frequency "10" reference voltage.

When the synchro-pulses appear, the capacitor C4 is charged through the tube. Within the pulse intervals the capacitor is discharged through the resistor R3. The detector output voltage shapes a distorted sawtooth. Since the recurrence frequency is modulated with frequency "10", the output constant component repeats the sine shape of the recurrence modulation.

From the detector load R8 the separated reference voltage goes to the low frequency amplifier through the filter R9, C5, RIO, C6 and the coupling capacitor C7.

The resistance amplifier has a negative feedback. The grid resistor RII by-pass the current constant component. The resistor RI5 provides the constant grid biasing and the negative feed back. The resistor RI2 is an L.F. amplifier plate load; the capacitance C8 is a plate supply decoupling. From the first stage plate load a frequency "10" voltage is fed to the second stage control grid (right half of Л 2) through the coupling capacitor CI4 and the resistor RI6. From the second stage cathode an "10" - frequency voltage is fed to potentiometer RI70 through the coupling capacitor C2[illegible]

to compensate the error-signal recurrence frequency modulation. The reference voltage goes from the right half of Л2 plate to the amplitude adjusting potentiometer RI9 ("Amplitude"). From the potentiometer RI9 slider the reference voltage is fed to the phaseshifting stage (Л3 left half). The phaseshifting stage is a paraphase amplifier loaded by the phaseshifting network R22, CI2. The output phase is depends on the potentiometer R22 position. So, the reference voltage phase may be shifted, i.e. the unit phasing may be carried out, by means of the potentiometer R22 ("Phase").

The reference voltage is fed from the phaseshifting stage to the amplifier Л3 (right half), which is loaded by the phasesplitter bridge: CI5, R24, CI6, R26, RI47. The bridge element values are matched so, that an arm middle point voltages are phase-different between themselves by 90° ("reference voltage 0°" and 90°). The precise 90° phaseshift is set by means of the potentiometer RI47. The resistor R25 is the left half tube Л13 gridleak in the "A" - regime.

The reference voltages (0° phase and 90° phase) are fed to the driving voltage channels through the regime "A" normally closed contacts I-2 and 4-5 of the relay P-I. The regime "B" frequency "F Я" reference voltages (0°phase and 90° phase) are taken from the unit KI-7M reference generator. This voltages go to the unit KI-6M input through the unit KI-I3M. From the plug Ш 5 pins I0 and II the reference voltages go through the divider R86, R85, R84, R83 to the relay "P-I" contacts 6-4 and 3-I and after that go to the driving voltage channels.

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2. The driving voltage channels "Y" and "Z"

The channel "Y" is identical with the channel "Z" excepting the reference phase difference, which is equal to 90°. The 0° phase and 90° phase reference voltages are applied to the reference amplifiers (left half of Л4 - "Y" Channel and left half of Л13 - "Z" channel).

"A" - regime

The 0° and 90° phase frequency "Ю" reference voltages are applied through the relay PI contacts 2-1 and 5-4 to the amplifier control grids.

"B" - regime

The two unit KI-7M reference generator frequency "Я" output voltages, phaseshifted by 90°, are fed through the relay P-I contacts 3-I and 6-4 to the amplifier control grids if the command N 2 is locking on.

Let us examine the channel "Y" diagram only, becdurse the channel "Z" is identical with it. From the reference amplifier plate load R83 (R120) the amplified voltages through the capacitor C42 (C49) and the resister R92 (R123) is fed to the phaseinverter control grid. The phaseinverter or the paraphased amplifier is the right half tube Л4 (Л13).

The two equal and antiphased reference voltages are taken out from the plate resister R91 (R122) and from the cathode resistors R96, R94, R95 (R124, R125, R126) and they are fed through the coupling capacitors C19 (C36)

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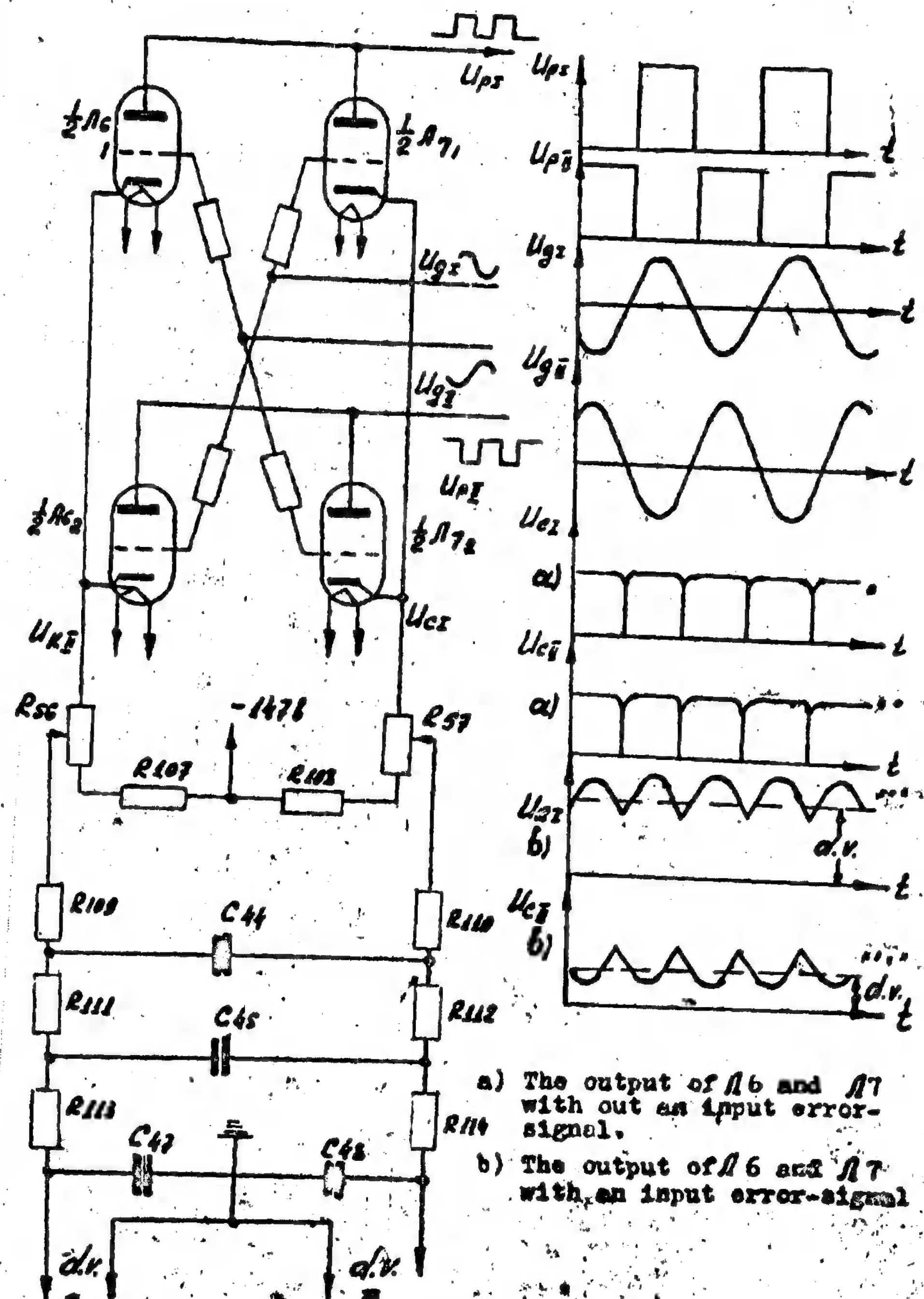
and CI7 (C34) to the clipping amplifier grids. Besides that the 0° (90°) phase reference voltage goes from the resistor R95 (RI26) to the plug connection Ш 6 pin 6 (7) for the unit monitoring and tuning.

The clipper amplifier Л5 (ЛI4) operates in a cutoff regime from below and above. The input sinusoidal voltage transformates into the antiphased squarewave pulses, which are taken from the resistors R99, RI00 (RI30, RI3I). The pulses are applied to the plates of the commutating tubes. The resistors R98 and RI02 (RI33, RI29) provide the grid current limitation.

The phase detector circuit consists of the cathode followers, which plates are fed by the antiphased rectangular reference pulses. The antiphased error-signal sinewaves are applied to the control grids of the cathode followers. The pulse reference voltage feeding the above tube ($\frac{1}{2}$Л6/I; $\frac{1}{2}$Л7/I) plates is antiphased with the one feeding the below tube ($\frac{1}{2}$Л6/2; $\frac{1}{2}$Л7/2) plates. The error-signal voltages applied to the grids of the tubes $\frac{1}{2}$Л6/I; $\frac{1}{2}$Л7/2 and the tubes $\frac{1}{2}$Л6/2, $\frac{1}{2}$Л7/I also differ by 180°. Let us examine the circuit operation. The detector tubes commutate in turns: $\frac{1}{2}$Л6/I and $\frac{1}{2}$Л7/I or $\frac{1}{2}$Л6/2 and $\frac{1}{2}$Л7/2.

If an input error-signal is absent, a constant voltages U_{kI} and U_{kII} are obtained across the cathode loads as a result of rectification. When the error signal is at the phase detector input, the values U_{kI} and U_{kII} vary with dependance from a phaseshift between the reference voltage and the error-signal. In this case a cathode output pulsating voltages are obtained, and its constant component is



a) The output of Л6 and Л7 with out an input error-signal.

b) The output of Л6 and Л7 with an input error-signal

Fig. № 31. The Phase-detector diagram.

proportional to error-signal amplitude and Cos of phase shift angle between reference voltage and error-signal voltage. This rectified voltage goes to the power amplifier through the 3-section RC-filter, which suppresses the a.c. component.

The power amplifiers Л17 and Л18 (Л19, Л20) are a cathode followers. The tube halves are connected in parallel to increase the linearity range of the driving voltage dependence on the tube current. The driving voltages are fed to the autopilot from the cathode loads RII7 and RII8 (R149, R150). A cathode follower balancing is carried out by means of the twin potentiometer R56 (R128), when the phase detector input error-signal is equal to zero. The potentiometers are installed on the unit front panel with the "Balance Y". ("Balance Z") inscription. The power amplifier plate power supply is fed through the voltage dropping resistor RII5 (RI46). Since the operational summary cathode follower current is approximately constant, the plate voltage is not vary practically. The output driving voltages are led to the plug Ш6 pins IO-II and 12-13 from the cathodes of the tubes. The driving voltage loads of the channel "Y" and the channel "Z" are a resistors equal to I kohm.

3. The channel of the error-signal separation

The error-signal channel is provided to separate a signal which is proportionate to a percentage amplitude modulation of the input pulses and is not depend upon the pulse amplitude. The positive pulses, amplitude modulated with frequency "Ω" and recurrency frequency modulated with the

percentage I.I%, are applied to the regime "A" detector - A.G.C. (the variable-mmtube Л9) through the socket N 27. The detector function is carried out by the grid-cathode space. The A.G.C. is essential for exluding the output signal dependance on the input pulse average amplitude. The envelope amplitude corresponds the input pulse average amplitude, when the A.M. percentage is constant. The detected constant component determines the operational point of Л9. So, the large pulse average amplitude detecting will case the large negative control grid biasing and decreasing of the tube gain. There is set the regime in which the output error-signal varyes less than 10% within the pre-set input pulse amplitude variance range. The regime is set by means of the tube Л9 screen voltage adjusting (by variance of a resistor R9 value). The negative feedback frequency "f0" voltage is applied to the control grid from the error-signal channel amplifier phaseshifting network. This voltage suppreses the error-signal component, determined by the pulse recurrence modulation, which case the parasite variance of the error-signal amplitude and phase.

The compensation ratio is adjusted by the potentiometer R170. The tube Л9 plate load is the time motor range potentiometer R64; so the error-signal channel gain increases as a determined function of time, when the time motor is moving. The range potentiometer slider error-signal is fed to the potentiometer R57 " f0 -gain" through the coupling capacitor CI0. The error-signal amplitude and with it the regime "A" driving voltage transconductance may be varied by the potentiometer R57.

The potentiometer R67 slider error-signal goes to the selective amplifier input through the normally closed contacts 14 and 13 of the relay P-I. The selective amplifier (Л10 and Л11 left half), provided for the error-signal first harmonic selection, is an underexited R-C generator.

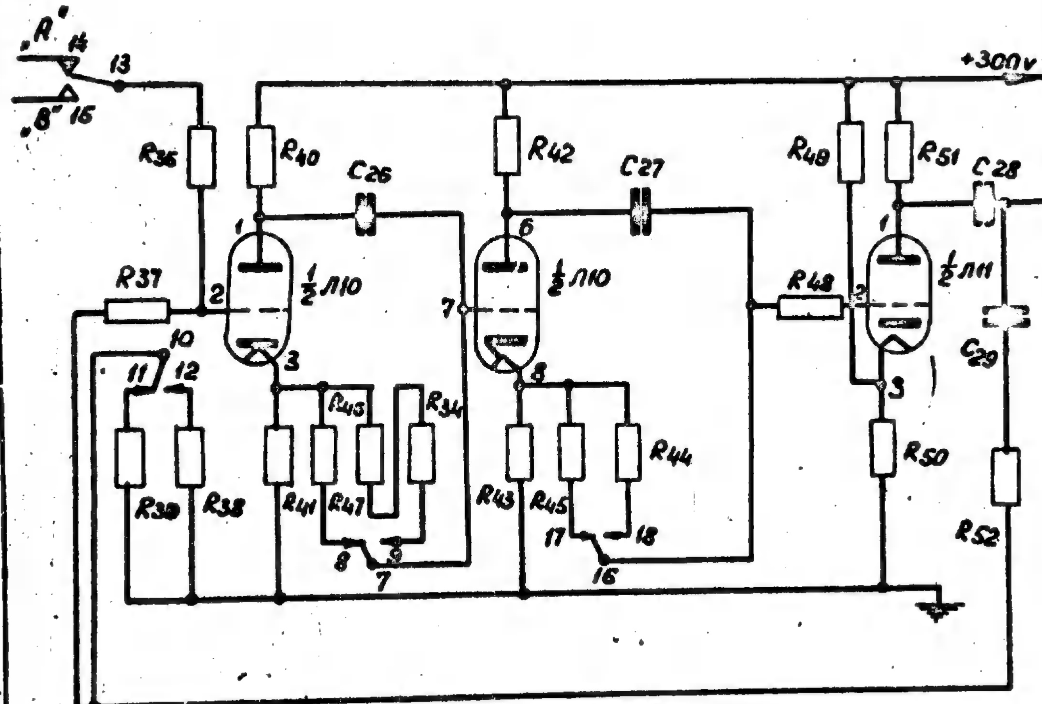


Fig.N 32. The selective amplifier

The selective amplifier is a 3-stage amplifier with a frequency discriminated positive feedback. The first two stage diagram is analoqous to the reference channel phaseshifter diagram. The third stage is an ordinary

resistor amplifier. Since the feedback voltage phase depends on a frequency, the amplifier phaseshifting elements should be set, so, that the feedback overall phaseshift is equal to 360° at the error-signal frequency "Ю" in the regime "A" and at the error-signal frequency "Я" in the regime "B". The first stage has the 60° phase shift owing to the phaseshifting network C26, R34, R46, R47, R41. The second stage carryes out the 90° phase shift, owing to the network R43, R44, R45, C27. The third stage carryes out the 180° phase shift. The feedback network C29, R52, R39, R38, carryes out 30° phase shift. approximately. To provide the precise 360° phase shift, the first stage phase shift is adjusting by the resistor R47 for the "Ю" - frequency and by the resistor R46 for the "Я" - frequency.

If a frequency is not equal to "Ю" in "A"2regime or to "Я" in "B"-regime, the overall phaseshift isn't equal to 360° and accordingly the positive feedback decreases. The selective amplifier frequency response is a resonance curve with at the "Ю"-frequency in the regime "A" or at the "Я"-frequency in the regime "B". The amplifier frequency response bandwidth depends on the feedback voltage value and adjusts by means of the feedback divider (R39 in "A" - regime and R38 in "B"-regime).

When the command N 2 looks, the selective amplifier is retuned from the "Ю" - frequency to the "Я" - frequency by means of the relay P-1, which switches the resistors of the pheseshifting network and the feedback divider. The resistors R36 and R37 serve for a decoupling of the input and feedback networks.

The resistors R49 and R50 Provide an essential bias of the tube Л11 grid.

A selected and amplified error-signal goes from the left half tube Л11 plate load R51 to the paraphase amplifier through the coupling capacitor C28. The two output antiphased voltages are taken out from the cathode and plate loads of the paraphase amplifier. The cathode and plate loads are so adjusted that both of the output voltages have equal amplitude.

The paraphase amplifier cathode output error-signal is fed to the cathode follower (Л11 right half) grid. The later gives away the tracking beacon signal through the plug connection "Ш -6" pin 8 and the K1-13M unit to the unit K1-12MP input. The same signal isn led through the same plug pin 9 for a selective amplifier tuning and an operation monitoring of the error-signal channel regime.

The "B" error-signal channel consists of the error-signal detector, the error-signal A.G.C. tube, the selective amplifier, the phaseinvorter (or paraphase amplifier) and

the cathode follower. The latter three are common with the "A" error-signal channel. The phaseshifting network is tuned at the "Я" - frequency by the relay P-1 in the "B" regime. The socket N 24 videopulses, amplitude modulated with, Я -frequency, are applied to the detector Л8. The detector and A.G.C. circuit operates analogically to the "A" detector and A.G.C. circuit.

The capacitor C23 charging time constant determines by an internal resistance of the grid-cathode space of the tube Л8, and the discharging time constant determines by the resistor R32 value.

The error-signal "Я" detected voltage is amplified by tube Л8 and led to the potentiometer R68 through the capacitor C25. The tube regime is adjusted by the resistor R73 and the divider R79, R73 so, that the output error-signal variance is less than 15%, when the input pulse amplitude varyes in the pre-set limits.

The potentiometer R-68 ("Я" - gain") serves for manual adjusting of the error-signal gain in the "B"-regime.

The error-signal goes from the potentiometer slider through the relay P-1 closed contacts 15 and 13 to the selective amplifier input.

Лит	К-во	№ прик.	Подпись	Дата	Лит	Кол	№ прик.	Подпись	Дата	Разраб. Провер.

4. Time motor

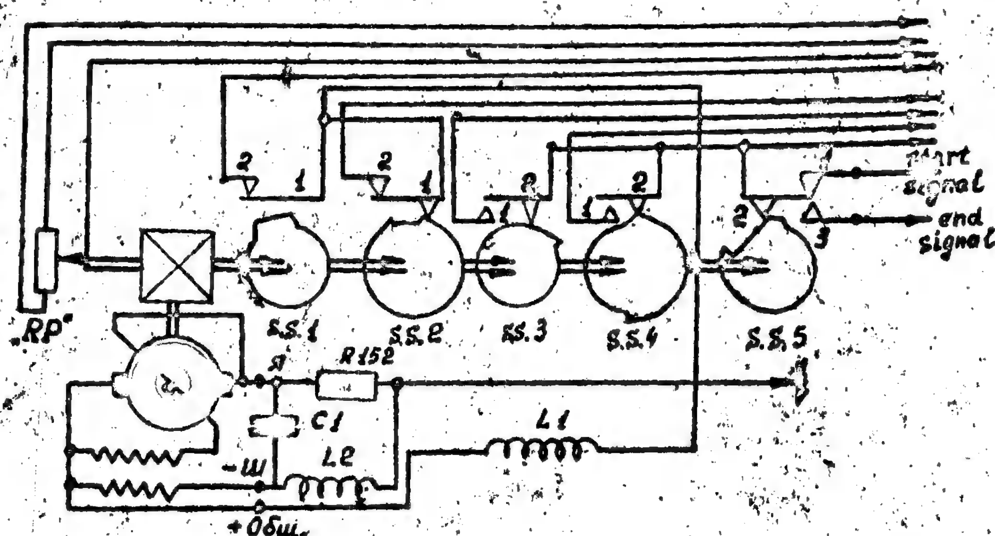


Fig.33

When the time motor is in start position the spring set 2 contacts 1 and 2 are closed the spring set 5 contacts 1 and 2 are also closed and the start signal is on the plug connection Ш6 contract № 16.

The range potentiometer R64 slider is in the isolated starting position. The spring set 1,3,4 contacts 1 and 2 are open. When the voltage +27v is applied to the plug "Ш5" pin 13 ("drop command"), the time motor starts moving.

The motor rotating is geared through the reducer to the cam spindle and with it to the slider of the range potentiometer.

The spring set 5 contacts 1 and 2 became opened and the start signal is put an end in the 3 sec. time.

The range potentiometer slider moves from the above to below (accordingly to the elementary diagram - to the Л9 plate).

After 39 sec., the spring set 3 contacts 1 and 2 are closed and with it the voltage +27v appears on the plug "Ш5" pin 9 (i.e. the command N 1).

After 198 sec, the spring set 4 contacts 1 and 2 are closed and the voltage +27v appears on the plug "Ш5" pin 15 (command N 2 unlocking signal).

When the range potentiometer reaches the end position (i.e. latest turns of the potentiometer), the spring set 5 contact 2 and 3 closed and with it is produced the "end signal", (+27v) which is led to the plug Ш6 pin 15. In the same time, the sping set 2 contacts 1 and 2 became opened, the spring set 1 contacts 1 and 2 became closed and the time motor is stopped.

To return the time motor in the starting position, the voltage +27v should be applied to the plug connection "Ш5" pin N12.

§6. The unit K1-7M

The unit consists of:

1. The reflector and the exiter.
2. The retary joint.
3. The flexible waveguide section.

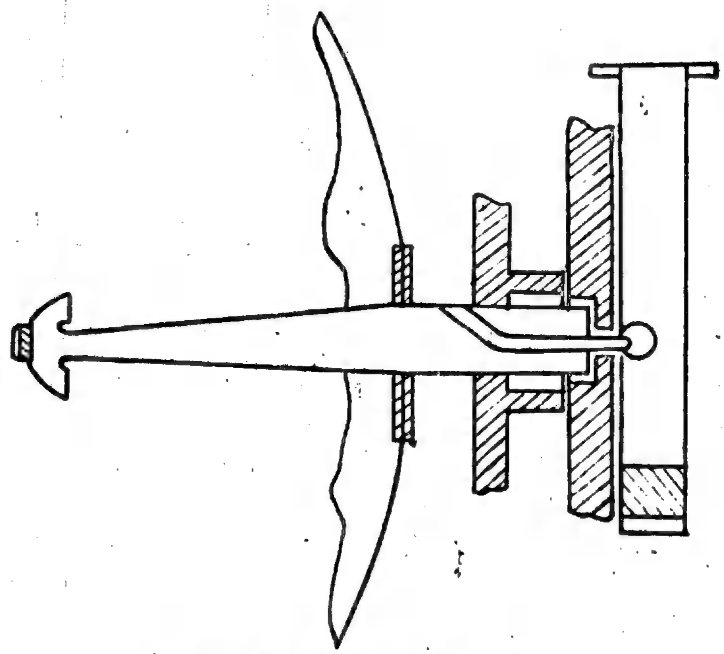


Fig.34. The antenna K1-7M

The antenna is a paraboloid 340mm in diameter, fed by a rear waveguide feed at its focus (F=132 mm). The head of the feed (exiter) is a forked and back bended waveguide. To obtain the conically scan, the exiter head is displaced from the reflector axis by means of a waveguide curving.

The feed picks up an electromagnetic waves, focuced by the reflector and exites the H_{01} wave in the feeding waveguide. The rotating joint consists of the two wavequides, one normal to another, which are jointed by means of the coaxial line. The coaxial is coupled with the stationary waveguide by means of the ball probe, and with the rotary waveguide by the coupling loop.

The rotary waveguide H_{01} mode transfarmes into the coaxial line EH mode symmetrical wave.

The ball probe installed in the stationary waveguide excites the H_{01} mode wave in it.

The rotary connection is made in the outer conductor of the coaxial. To exclude the U.H.F. energe leakage, the half-wave "choke" is provided.

The ~~flex~~ flexible corrugated brass made waveguide provides the energy transition, when the unit K1-7M is slightly moving relatively to the framework.

The unit K1-7M scanning device is provided to obtain the conically scanning of the beam in a space and to produce the two sinusoidal 90° phaseshifted voltages (reference voltages). This voltages are produced by the reference generator. The rotating is obtained by the motor "ДП-31", which has a centrifugal governor in an exiting circuit.

The unit K1-7M fastening device is an aluminium frame, which has three hinge bearings with bolts to fasten the unit in the correspondance threading holes of the misile "ЖС".

When is a voltage +27 v on the plug connection pins 1 and 2, the motor is fed.

The centrifugal governor of the motor provides a rotation speed constancy, when the power supply varies.

The motor spindle is geared with the exiter spindle and the reference generator rotor by means of the reducer with the transmibion ratio 1:2, so the reference generator operates synchronous to the beam rotating.

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Ф. XVа

The two sinusoidal reference voltages, led to the plug pins NN 3,4,5 and 6, are equal to 30±2v.

§ 7 The unit K1-8M elementary diagram

The unit input circuit is the coupling with the single diode mixer by means of the inductance L1 and L2. The inductances with the capacitor C72 and the strap circuit and cables capacitances form the I.F. tuned resonance circuits. The capacitors C2, C3, C4, the inductances L3, L4 and the resistor R5 form the crystal current line filter.

The I.F. pre-amplifier is taken away from the unit K1-8M chassis and placed into the unit K1-4M plate. This spacing improves the noise-figure of the receiver.

The I.F. pre-amplifier consists of two stages "6Ж1П", triode connected. The first stage is a grounded cathode circuit. The second stage is a grounded grid circuit. To neutralize the first tube grid-plate capacitance, the inductance L6 is, which besides that, bypass the second stage current constant component.

To neutralize the second stage cathode-plate capacitance, there is the inductance L8, which with the same capacitance form the I.F. resonance circuit.

The Л1 plate inductance L7 with the circuit capacitance and the tube internal capacitance form the I.F. tuned circuit

The Л9 circuit is connected into the Л2 plate line and shunted by the resistor R4. This circuit is connected to the I.F. amplifier input circuit by means of the short coaxial cable.

These two circuits with the capacitors C15, C15 and cable capacitance form the I.F. bandpass filter.

For the purpose of self bias, the cathode resistors R1 and R3 and the capacitors C1 and C8 are.

To provide the operational stability the decoupling filters are (the plate filter Л10, C9, C10, the filament filters Л12, C12 and C13). Besides that, there is the every tube filament filters: consisted of L5, L11, C5, C11.

The main I.F. amplifier consists of five 6Ж1П stages Л3, Л4, Л5, Л6, Л7). The tubes are parallel fed and have the circuits in the grid networks.

The whole of the I.F. amplifier consists of the two staggered triples. The I.F. preamplifier and the 2 first stages the main I.F. amplifier form the first triple; the next 3 stages form the second triple.

The I.F. amplifier circuits are tuned to:

1. The I.F. preamplifier with the first circuit of I.F. main amplifier f = 40 Mc;
2. The I.F. main amplifier first stage ff = 42...
3. The I.F. main amplifier second stage ff = ...
4. The I.F. main amplifier third stage ff = 42...
5. The I.F. main amplifier fourth stage ff = ...
6. The I.F. main amplifier fifth stage ff = 40...

When the Radar is operated in the regime "A", the negative voltage -147v goes from the plug connection Ш3 pin N 15 and from the divider R26, R27 to the screen grid of the I.F. last stage; so the receiver is cut off.

When the regime "B" is switched on, the voltage -147v is taken away from the plug Ш3 pin N 15, since the unit KI-I?M relay P-I operates. So the divider R26, R27 negative voltage is applied to the Л7 screen grid only. In the moment, when the unit KI-9M strobopulses, having amplitude 80v - 130v, go to the socket Ф-22, the Л7 screen voltage become positive, so the receiver opens.

When tuned and adjusted, the receiver may be open by applying a positive voltage (+130v) to the Л7 screen grid by means of switching the toggle switch in the position "+".

The A.G.C. negative biasing is applied the to the controll grids of the first 4 I.F. stages. through the filters C18, R8, C23, R12, C28, R16, C33, R20.

The coils L14, L16, L18, L20, L22 and the capacitors C19, C24, C29, C34, C39 form the filament filters , of tubes. To avoid the 400c induction to the I.F. circuits, the filament wiring is carried out by a shielded conductors. The resistors R7, R10, R15, R19, R23 and the capacitors C17, C22, C27, C32, C37 provide a tube self biasing.

The C21, C26, C31, C36, C42 are inter stage coupling capacitors. To provide an operational stability, the RC filters are in the plate networks of the I.F. amplifier. An I.F. signal pulses go from the last I.F. stage to the detector Л8, which is diode connected. The plate and the

screen grid are jointed and grounded through the resistor R28, bridging by the capacitor C45.

The network R28, C45 determines a tube potential distribution and increases the detector efficiency. The plate of the detector is a tube control grid.

The capacitor C46 and coil L25 are an I.F.filter.

The positive output pulses are taken from the detector load R30 and applied to the control grid of the first video-amplifier through the capacitor C47.

The two stage video-amplifier (Л9 and Л10) is a resistor-coupled wide-band amplifier with a positive feedback through the coupling network R34, C49.

The negative feedback is carried out through the resistors R32 and R36. This circuiting has no requirement to big value of the cathode and screen bridging capacitors.

The positive feedback between the 1-st and the 2-nd stages increases a gain ang compensates a gain decreasing occasioned by the negative feedback. When the frequency became high, the impedance of the network R34, C49 decreases and with it the positive feedback and the gain increases. So the capacitor C49 compensates the steep slope of a frequency response curve. For the purpose the compensating coil L31 is placed in the plate load of the video-amplifier second stage.

The 2-nd video-amplifier output positive pulses are fed to the cathode follower grid (Л11 right half). The A.M. posi-

tive video-pulses go from C.F. load potentiometer (R-48) to the unit output socket N 24 by a coaxial cable.

The error-signal amplitude may be adjusted by the potentiometer R-48.

The C.F. overall load (R39 and R48) output pulses are led to the control grid of the A.G.C. plate detector (Л12 right half). through the coupling capacitor C52 and to the Л11 left haef grid through the capacitor C58.

The negative delay voltage is applied to the A.G.C. detector grid (Л12) from the divider R41, R42.

The Л12 plate load is shunted by capacitor C54.

The network R49, C57 is a plate filter.

To vary the delay voltage, the divider negative voltage is led into the A.G.C. line, The voltage may be variated by the "M.G.C." potentiometer R47 and monitored at the jack "Manual G.C.".

When an input pulse is larger than the delay voltage, the tube Л12 is cut in.

The Л12 plate output voltage is applied to the control grids of the tubes Л3, Л4, Л5 and Л6.

The Л12 left half is a cathode follower and it serves for the A.G.C. monitoring.

The A.G.C. output voltage may be monitored at the jack Г-1 (A.G.C.) on the unit K1-8M front panel.

The tube Л11 left and the tibe Л13 right half are two stages of the video-amplifier, which inject the pulses to the

K1-9M unit.

The tube Л13 left half is a cathode follower; the load R62 output pulse goes to the socket N 23.

The plate compensating coil L29 of the Л13 right half improves the pulse shape.

The control grid biasing of the cathode follower and of the first video-amplifier is obtained from the voltage divider R66, R65, R64.

The unit K1-8M d.c.power supply is provided by the rectifier K1-10M, which produces the following voltages:

1) +130v regulated;
2) +300v unregulated;
3) -147v regulated.

The unit K1-8M filament power supply is carried out by the special transformer "TP-1" from the 115v 400c source. The all feeding voltages are led into the unit K1-8M by the connection plugs Ш2 and Ш3.

§ The unit K1-C'1 elementary diagram

1. The seaching regime

When the Radar is switched on, the autoselector (or range unit) starts a searching over the range band. The input pulses going into through the socket N 25 have an amplitude within 35v ÷ 60v and a pulse duration within 0.7÷1.0 μsec.

The input synchro-pulse triggers the multivibrator Л10 through the buffer (Л9 left half), which is normally cut off by means of a negative bias from the divider R77, R78. When the synshro-pulse is injected the tube Л9 left half cut in and produce the plate load negative pulse.

The miltivibrator (M.V.) left half is normally cut in, the right half is normally cut off by means of a voltage, which the left half current develops across the common cathode load R86.

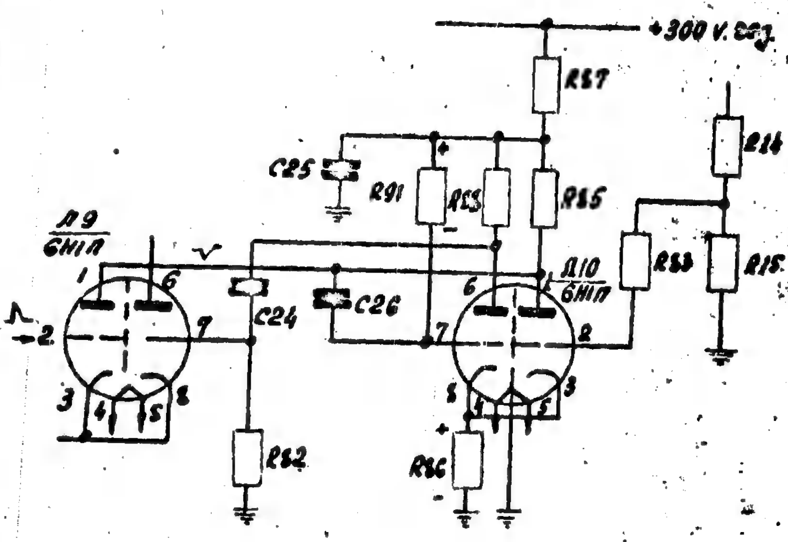


Fig.35. The multivibrator diagram

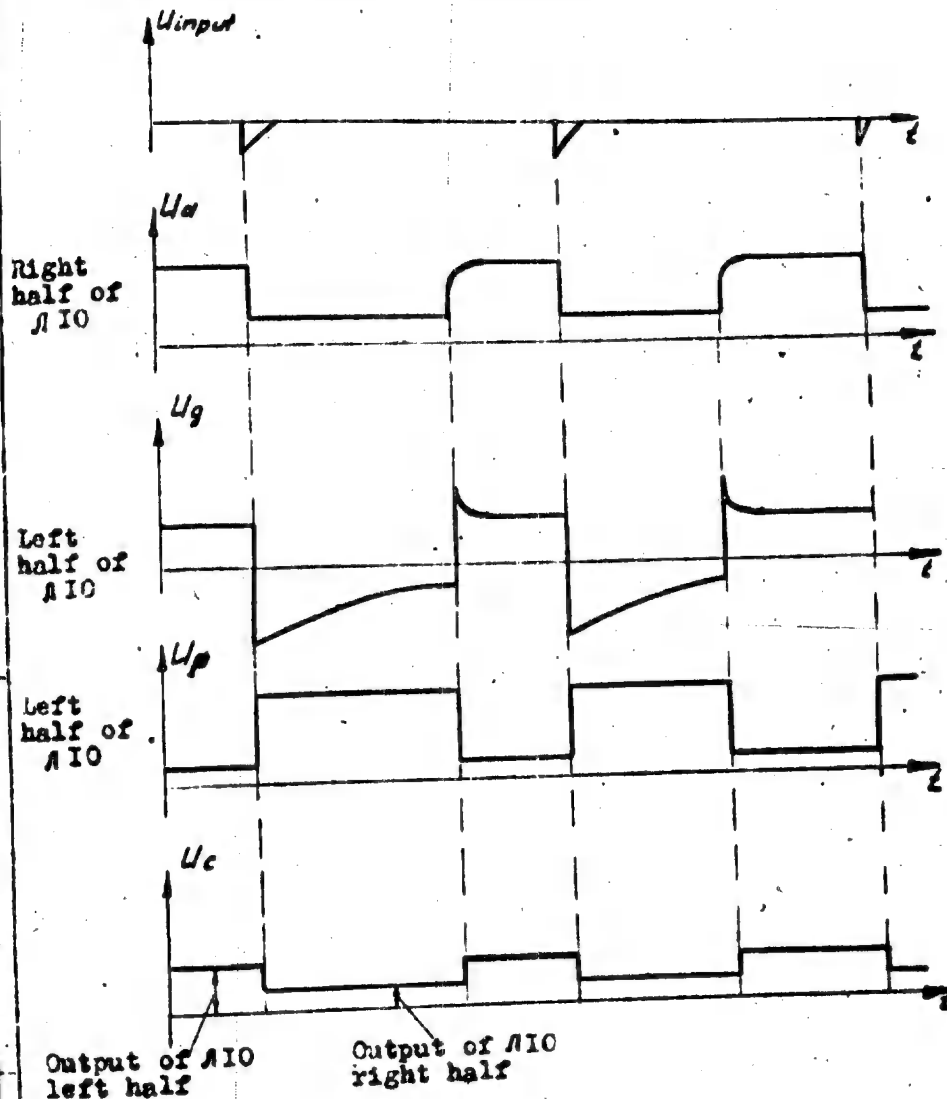


Fig. N 36. Time relationship of multivibrator.

When synchro-pulse is injected, the buffer plate negative pulse, transmitted through capacitor C26 decreases a potential of the left grid and, with it, the current of left half. So, the cathode drop will be decreased and a current appears through the right half. The plate drop is transitted at the left half grid and the left half become to cutting of. The avalanche-type process develops, as a result of which, the left half become cut off and the right half become cut in.

When the right half is cut in, the capacitor C26 become to discharge across the network, consisting of the right half, the resistor R86, the power source and the resistors R87, R91. The negative resistor R91 drop voltage is applied to the left half grid and cuts out the left half. Since, the discharging current is exponentially decreasing the left half grid voltage become to increase.

The process lasts till the capacitor voltage become equal to a value essential for turnover of the multivibrator. The higher voltage is applied to the control grid of the Л10 right half, the longer capacitor C26 recharge time is needed, i.e. the longer positive pulses will be made across the left plate lead R88.

Since the transitron sawtooth is applied to the M.V. right grid, the pulse length will be variating accordingly with the sawtooth low.

The multivibrator output pulses go to the differentiating circuit R82, C24. The differentiated M.V. pulses are fed to the control grid of the amplifier (Л9 right half). After the differentiating the positive pulses correspond to the M.V. pulse front edge and the negative pulses correspond to the M.V. pulse rear edge. The positive pulses are partially suppressed by means of zero biasing of the amplifier, and with it, a grid current. The positive pulses corresponded to the rear edge of the M.V. pulses are separated at the plate load R81, and than fed to the buffer Л11 control grids.

The buffer Л11 (6Н1П) is normally cut off by means of the divider R92, R93 negative biasing.

The positive pulses cut in the buffer and the positive pulses appear at the plate load R97 and at the windings of the pulse transformers; the later trigger the strobe blocking-generator and the half-strobe blocking-generator.

The tube Л12 (6Н1П) left half is a half-strobe blocking-generator, which output pulses go to the cathode-follower Л12 (right half). The loads of the cathode follower are the delay line Л3-1 and the resistor R98.

The cathode follower output "nondelayed" half-strobe is applied to the pentode and screen grids of the first coincidence stage Л4 (6Ж2П).

The delay line output "delayed" half-strobe is applied to the pentode and screen grids of the second coincidence

stage Л5 (6Ж2П). The time delay of the delayed strobe equal to 0.8 ÷ 1.0 μsec.

The strobe blooking-generator Л13 (6Н1П) is triggered by negative pulses from the Л11 left half.

The strobe duration is approximately 2 μsec. Than The strobe is applied to the cathode follower Л13 (left half) grid. The cathode follower output pulses are fed to: the command N 2 coincidence stage Л14 (left half) and to the socket N 22. The resistor R103 strobe is led to the monitoring jackГ2.

In seaching regime the M.V. pulse lenght is periodically variated from longer value to shorter value and it carry out the variance of a spacing between the synchro-pulse and the half-strobe (or strobe).

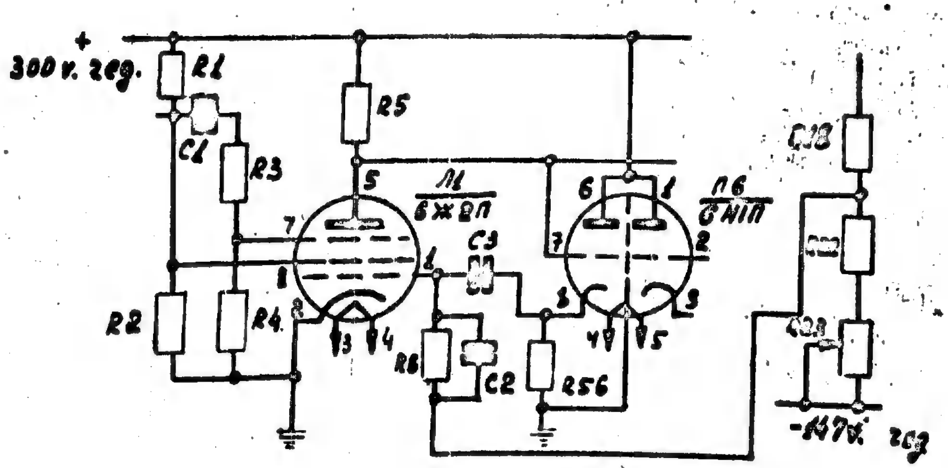


Fig.37. The transitron generator diagram.

The M.V. pulse length variance is carried out by means of the controlling cascade Л1 and Л6 left half. The cathode follower Л6 (left half) with the capacitor C3 are a negative feed back network, which connects the plate and the grid of the tube Л1.

In seaching regime the controlling cascade operates as a transitron generator and produces the "sawtooth", which is fed to the grid of the cathode follower Л2 (left half).

Let us examine a transitron operation (see fig.N 39).

Let us assume, the Л1 plate voltage is decreasing and the controll grid voltage is increasing (the fig.N 39) space a-b).

When difference between plate voltage and cathode voltage will be small, there will be redistribution of a tube current between the plate and the screen grid so, that a screen current became to increase and, with it, became to increase a voltage drop across the resistor R1. The capacitor C1 became to discharge through the screen-cathode space and resistors R3 and R4. The C1 discharging current develops the negative voltage across the resistor R4, which is applied at the pentode grid and cut off the tube Л1 plate current. It leads to an increasing of plate voltage and control grid voltage and, with it, to the screen current increasing still more. Than became the regeneration (the fig.N 39 point "b"). The capacitor C3 became to charge by power supply through the R5, the cathode follower

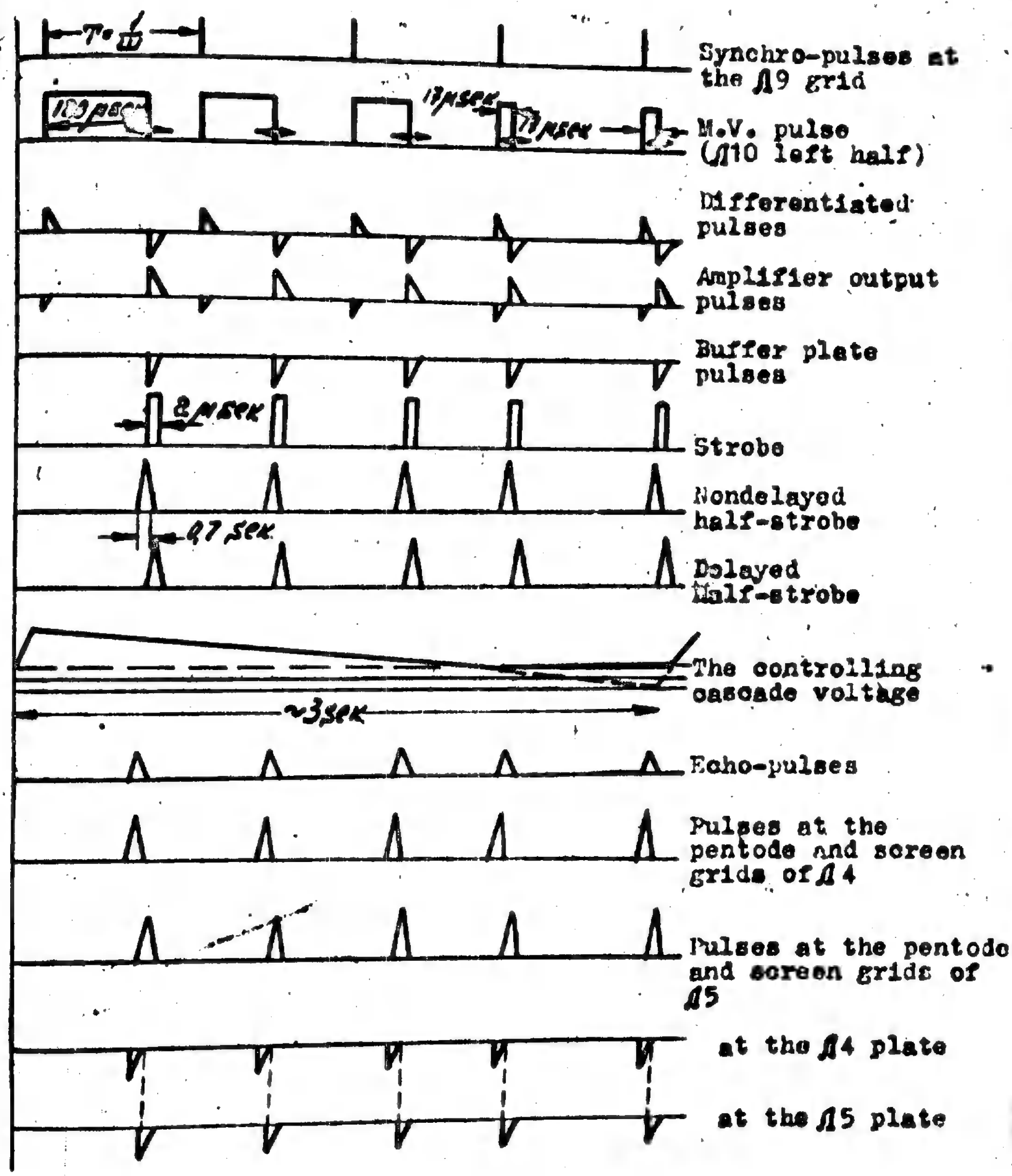
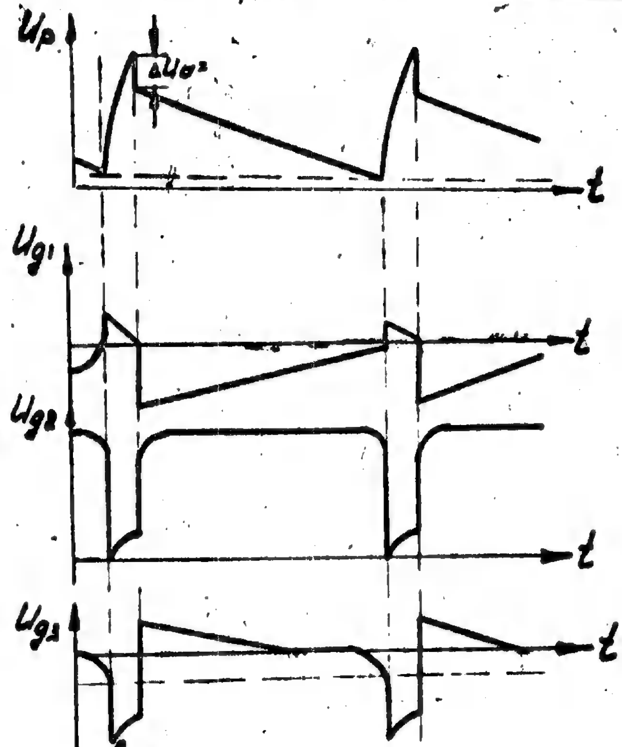


Fig.38. The autoselector time relationship



a б c Fig.39

grid-cathode space and the tube Л1 grid-cathade space to the plate voltage value.

The Л1 plate voltage is increasing (relatively the cathode voltage value). The pentode grid nerative voltage is decreasing with the capacitor C1 discharging. When the pentode grid voltage became near to the cathode potential. the plate current appears (the fig N 39 point "c") and devepops the voltage drop across the resistor R5, which is applying to the control grid of Л1. It leed to a new redistribution of the tube current, the plate current sharply increases, the screen grid current sharply decreases.

and with it, the screen grid voltage increases, the capacitor CI became to charge again, and the pentode grid voltage became positive. As a result the plate current increases still more.

In the moment of plate current jump (point "c") the control grid voltage becomes suddenly negative and practically equal to the tube cut off value, i.e. the capacitor C3 discharging network consists of the power source and resistors R56, R23, R22, R6 only. As the capacitor C3 is discharging, the control grid voltage is increasing, the plate current is increasing also, and the plate voltage is decreasing. If the negative feedback between the plate and the tube I control grid will be absent, the process will be a kind of avalanche-type increase of the plate current till the screen current drops to zero and the plate voltage decreases extremely.

Owing to the strong negative feed back, the plate current increase process flows more slowly. The plate voltage decreases slowly also. When the plate voltage is near to the cathode voltage (fig.39 point "d") new redistribution of the current is happened. The regeneration starts and the process will repeat. The capacitor C3 charging is carried out in sawtooth back stroke time (C3 charges till the I plate voltage will be reached). The back stroke time is determined by the time constant CI (R3+R4).

The forward stroke time is determined by the time constant of the network C3 (R6+R56+R22+R23).

The transitron output sawtooth period is determined with the generator control grid biasing which is obtained by

means of the potentiometer R21 ("seach speed").
The tube Л2 left half ("seach start tube") serves for transmitting the control cascade output signal to the M.V. control grid. In searching regime, the cathode follower output sawtooth is clipped from below by means of the grid current of the tube Л6 (right half), which has a common load R14, R15, R8 with the tube Л2 left half. So the seaching start point or the minimum searching limit may be changed by means of the potentiometer R53. Besides that the maximum limit of searching may be changed by means of the potentiometer R12, which provides the biasing of the M.V. control grid and, with it, the M.V. pulse length. The potentiometers R12 and R53 are placed on the unit front panel with inscriptions: "search range" and "search start".

The command N 2 device

The input echo-signal goes through the socket N 23 and the capacitors CII and C50 to the coincidence stage Л14 (6H1П left half). The tube is normally cut off by means of a negative biasing from the divider R107, R108, RIII and zero plate voltage. When the echo-pulse is applied to the grid and the strobe-pulse is applied to the plate, the tube is cut in, and with it, the negative voltage is developed across the load R105. The later charges the capacitor C51 negatively through the resistor R106. When the echo-pulse amplitude became enough, the voltage cut off the tube Л15 and with it, the relay P-2 winding became currentless. As a result of that, the contacts I and 2 became open and the relays PI and P4 became currentless.

25X1

Which causes the following switchings:

I) The relay P-I through the closed contacts 1 and 2 feeds the command N 2 signal (+27 v.) to the plug connection Ш4.

2) Since the relay R-2 contacts 6 and 7 are open and the contacts 4 and 5 are closed, the slider of the potentiometer R21 "search speed" is disconnected with the "accumulator" Capacitor, when the large capacitance C53 is connected in parallel with the capacitor C6.

3) The relay P4 through the closed contacts I and 2 cut off the cathode follower Л6 (right half).

The clipping diode Л14 (right half) limits the tube Л15 grid negative voltage to provide the relay P2 release time independance from the echo-pulse amplitude. The clipping is carried out by means of the diode cutting in, when the negative voltage of the capacitor C51 (or at the tube Л15 grid) became equal to definite value.

The time constant of capacitor C51 discharging through the resistors R105 and R106 provides the tube Л15 cutting off during 2.5 + 3.5 sec (the command N 2 cutting off delay time) after the echo-signal disappearing. As a ~~xxxxxx~~ result the command N 2 is not cutt off during 2.5 - 3.5 sec after the echo-signal disappears.

Tracking regime

The range autotracking regime consists in the strobe delay time changing, depending on the echo-signal delay time relatively to the syncho-pulse. In tracking regime the time discriminator becomes to operate and the controlling cascade operates in the d.c. amplifier regime

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S-E-C-R-E-T

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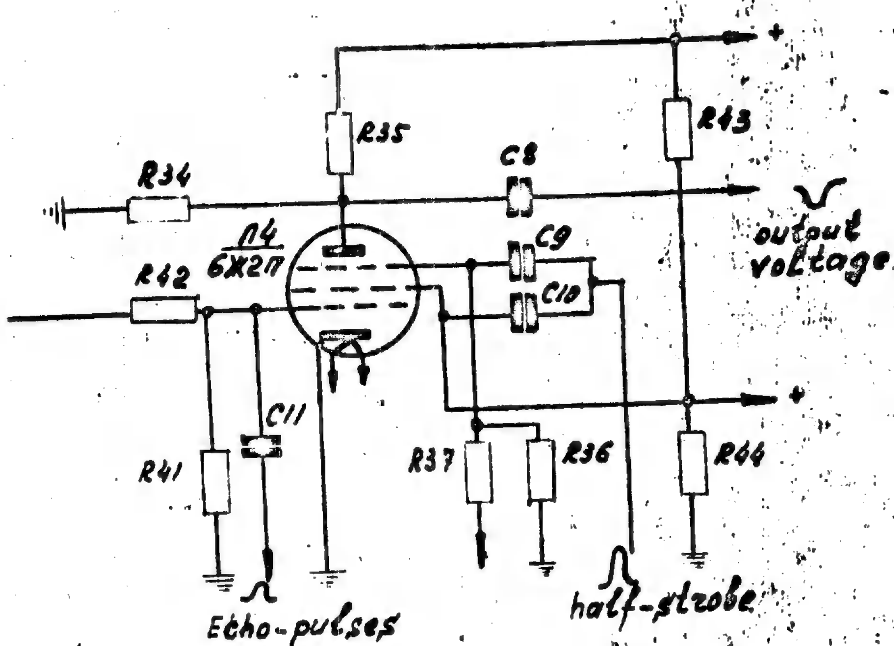

Fig.N 40. First coincidence stage.

The coincidence stages are the type 6Ж2П tubes Л4 and Л5. Both of the stages are normally cut off by using the negative biasing of the pentode and control grids from the dividers R42, R4I, R36, R37, R46, R47. The divider R43, R44 positive voltage supplies the screen grids. The echo-signal is applied to the control grids from the socket N 23. The positive half-strole pulses are applied to the pentode and screen grids.

The difference detector is a type 6 Х 2П double diode tube Л3. Both of the diode are normally cut off. The righ one is cut off by the plate voltage approximately equal to -50v; the left one - by the cathode voltage equal approximately to +I00v. Let us eximine two time disposition

of the half-strobes relatively the echo-signal.

The first case is when the echo-pulse coincides with the nondelayed half-strobe and is not coincide with the delayed half-strobe. As a result of this disposition, the tube Л4 output negative pulse will be produced. The pulse amplitude depends on the overlapping area of the signal-pulse and the half-strobe. The coincidence pulse cut in the detector right diode. As a result the "accumulator" capacitor C6 will be charging positively. The capacitor C6 voltage depends on the coinsidence pulse amplitude. The cathode followel Л2 (right half) grid and cathode potentials became to in crease. The increasing (is) transitted to the controlling cascade ЛI input. The ЛI plate current increasing speed became to increase and, with it, the half-strobes became to move more rapidely.

If the echo-pulse coincides with the delayed half-strobe, the left diode is cut in and the capacitor C6 will be charging negatively. The negative voltage, transitted to the controlling carcade input, decreses the ЛI plate current increasing speed; it carryes out the transitron generation stopping. The controlling cascade became to operate in the d.c. amplifier regime.

The "accumulator" voltage which is a result of the echo-pulse tracking dynamies, is amplified by the controlling cascade, cathode followed by the Л2 left half and applied to the multivibrator ЛI0 control grid.

The M.V. pulse length and with it, the strobe delay time are depended on the M.V. grid voltage.

-IIO

The echo-signal placed aproximately simmetrical relatively the half-strobes and the accumulator voltage is near to zero value, since the discharging current is equal to the charging one. In the tracking regime the echo-signal delay time is decreasing continuosly and the C6 voltage is within 0.3-0.5v.

The "accumulator" voltage adjusting is carried out by the potentiometer R23. The potentiometer installed on the front panel and inscripted as "accumulator voltage". When command N 2 is locked on , the capacitor C6 potential should be set equal to zero to compensate the nonidentity of the tubes and the circuit element of the time discriminator (tubes Л3, Л4 and Л5).

When the echo-signal is lookedon and the command N 2 is cut in, the relay P2 disconnects the slider of the search speed potentiometer R2I from the cathode follower Л 2 (right half) grid and connects in parallel with the capacitor C6 the large capacitance C53. As a result the "accumulator" time constant is increased greatly. Thanks to that , when the echo-pulse disappears, the cathode follower Л2 grid potential slow increasing is provided (by means of the accumulator capacitor recharging) and with it, the half-strobe moving is going on with the same speed and to the same direction.
So the time constant increasing provides the speed memory of the echo-signal tracking.

The unit power supply

The unit power supply is carried out by the voltages:

+300 v unregulated,
+300 v regulated,
-147 v regulated.

The filament power supply is carried out by the isolated filament tranformer, placed in the unit KI-13M. The all voltages are led into the unit through the plug connection Ш 4.

§ 9. The unit KI-10M elementary diagram

The unit KI-10M output voltages are:

I) +300 v. unregulated, loaded by 63 ma;
2) +130 v. regulated, loaded by 152 ma;
3) +300 v. regulated, loaded by 92 ma;
4) -300 v. regulated, loaded by 13 ma;
5) -147 v. regulated, loaded by 26 ma.

The 115 v 400c. primary fed the transformers Tp-I and Tp-2. The first one carry out the high voltage to feed the plates of the kenotrons and the regulator tubes. The plate transformer has a primary winding taps, which provides the high voltage variance, when the unit is adjusted.

The transformer Tp-I secondary voltage goes to the four fullwave kenotron 5Ц4С rectifiers. The capacitance-inductance П type filters are at the outputs of the rectifiers. The +300 v unregulated voltage is taken out immediately after the filter and its value may be changed by the series resistor RI. The resistor R2 is for the

Лит	К-во	№ прим.	Подпись	Дата	Лит.	К-во	№ прим.	Подпись	Дата	Проверил

safety sake, since it take out a residual charge from the capacitors C1 and C2 after the rectifier switching off.

The -147v voltage is taken out from the stabilovolt СГ3П (Л13), which is placed at the -300v regulated rectifier output. The -147v value is determined by the stabilovolt СГ3П (Л13) characteristic. The regulating circuits of the all rectifiers are identical. Its operational principle consists in voltage absorbing by the controlling tube, which is in series with the load.

The +300v and -300v voltage regulator circuits consists of the type 6 Н13С tube Л7 the type 6Ж1П tubes Л8 and Л11 and the СГ3П stabilovolts Л9 and Л12. The tube Л7 an absorbing tube, the tubes Л8 and Л11 are d.c. amplifiers, and the СГ3П type Л9 and Л12 are a reference voltage source. The +130v regulator tubes Л4 (6 Н13С type) and Л5 (6Ж1П type) carry out the same functions as they are in the previous rectifiers. The tube 6Н13С both triodes are connected in parallel to provide a large load current passing.

The stabilovolt "Л9" voltage divided by R35 and R36 is using as a reference voltage source of that rectifier.

The operational principle of the voltage regulator

When the output rectified voltage vary, the d.c. amplifier grid voltage also vary, since it is a difference between the part of the output voltage and the constant reference voltage of the stabilovolt СГ3П . This difference voltage is amplified by the tube 6Н13С and applied to the

controlling tube 6H13C grid to change its voltage drop. Let us examine the case, when the 115 v primary voltage is increased. It causes the rectified voltage increasing and with it an amplifier grid negative bias decreasing and the amplifier plate current and the plate drop voltage increasing. As a result of that the negative biasing and with it, the internal resistance of the controlling tube will be increased. The controlling tube internal voltage drop increases by the value equal to the voltage increasing before the regulator, i.e. the later will be compensated.

When the primary voltage decreases, the rectified voltage decreases the d.c. amplifier grid negative biasing increases, the plate current and drop decrease and the controlling tube 6H13C grid negative biasing decreases. As a result of it the internal resistance and the voltage absorbing of the tube 6H13C will be decreased by the value, equal to the rectified voltage decreasing.

When the load current decreases or increases, the rectified voltage also increases or decreases or decreases and the regulator circuit operates just as it was described above. The voltage rated values +300 v -300 v, +130 v are set by means of an amplifier tube grid biasing variance, which is carried out by the variable resistors R13, [illegible], [illegible] To improve the rectified voltage stability on unregulated voltage parts are aplied also to the d.c. amplifier grids from the voltage dividers R4, R16, R25. So the input voltage is also influences upon the d.c. amplifier grid. The influence process is analogical to the described above one.

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To decrease the output voltage pulsation the capacitors C6, CII, CI6 connect the positive terminals and the d.c. amplifier grids. To avoid a self-oscillation of the d.c. amplifiers the large capacitance C7,CI2 and CI7 are placed at the output.

To obtain an operational stability the resistors R9, R7, RI7, R26 are placed in the grid networks of the controlling tubes and the capacitors CIO, CI5, CI8 shunt the stabilovolts.

The resistors RI9, R28, R20, R29 serve as a ballast resistance of the stabilovolts and provide the normal current of the stabilovolts ЛI2 and Л9. To avoid the switching on interelectrode breakdown the controlling tubes are shunted by the resistors R5 and R34. The capacitors CI9 and C20 are provided to decrease the output pulsation.

§ 10. The unit KI-IIM description

The antenna KI-IIM description is given in the chapter VI.

§ 11. The unit KI-I2M elementary diagram

I. The triggering pulse amplifier.

The positive triggering pulses, which have an amplitude less than 8v and pulse duration 0.6-I.0 μ sec, go to the amplifier Л2 (left half) grid. The negative amplifier output pulses go to the multivibrator ЛI left plate. The plate receive their operation voltage through the filter R6, C4.

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2. The delay multivibrator

The double triode ЛI is a single stroke multivibrator, which is triggered by the pulses, applied to the plate. The M.V. makes the positive pulses with length equal to I70 μ sec. The M.V. pulse length may be variated by the resistor RI4, placed in grid network. When the frequency "Ω" voltage is applied to the M.V. grid, the operation regime changes so that pulse length is variated within ±20 μ sec relatively the initial delay time.

In "B" regime the command N 2 (+27v) is applied at the M.V. cathode by the relay R2. This voltage cut off the Л I left half, when the righ half became to operate as an amplifier. The output pulse length became equal approximately I μ sec.

3. The differentiated pulse amplifier

The M.V. output pulse is diffentiated by the network C7, RI2. After differentiating the positive pulses are clipped out by a grid current of the amplifier, since the biading is equal to zero. The negative pulses are amplified and fed to the normally cut off blocking-generator Л3 grid.

4. The preliminary blocking-generator.

The tube Л3 left half is a blocking-generator. The plate receive its operating voltage through the filter R2I, CI4. The tube Л3 is cut off by positive voltage applied to the cathode from the divider R2, HI. The positive amplifier output pulses applied to the blocking-generator grid cut in the tube and trigger an oscillation.

The blocking-generator output pulses are delayed by the M.V. pulse length. The tube Л3 right triode is a diode clipping the negative pulses. The diode is boaded by the cathode resistor R26. This circuiting improves the blocking-generator output pulse shape and is a decoupling between the pre-blocking-generator and the power blocking-oscillator modulator.

5. The blocking-oscillator/modulator/.

Thr power blocking-generator Л4 (ГИ-30) carry. out the modulation of the U.H.F. generator. The blocking-generator is normally cut off by means of large negative biasing (across the resistor R23). When applied positive amplitude I20v - I50v pulses at the grid, the blocking-oscillator is cut in.

The output pulses amplitude and length are determined by the tube ГИ-30, the pulse transformer and other circuit elements. The tube is supplied by the high voltage rectifier which is made as a Lature circuiting with the tubes 2Ц2С The plate voltage is approximately wqual to 2500v , the screen grid voltage is within 800v - 850v ; both the voltage are obtained from the voltage-divider network formed by R30, R3I and RI7.

6. The U.H.F. oscillator

The oscillator tube Л9 is the metal-ceramic type ГИ-I3C tube grounded grid circuited. The oscillator plate circuit is a cavity resonator. The grid circuit is a short-circuited section of a coaxial line. The cavity circuit has two tuners provided frequency and conpling tuning. The frequency tuning is carried out by means of the rod with the disk-shaped end,

which is led into the cavity. The disk position variance provides the plate circuit capacitance variance and, with it, theoscillator frequency tuning.

The antenna coupler is also a rod type. The rod is besides that an inner conductor of the output coaxial live with the short-circuited stub. The controlling of the antenna coupling may be carried out by leading in of the rod and also by changing the short-circuited stub length. The oscillator tube is plate modulated. When the modulating pulses are absent the plate voltage is equal to zero. So,an oscillation is only when the modulating pulses are applied to the tube plate. The U.H.F. pulse length is determined by the modulatin pulse lebgth on the whole. The modulating pulse amplitude provided an intensive oscillation must be equal to I600 approximately.

The antenna KI-IIM loads the oscillator and is co[illegible] with it by type PK-47 U.H.F. cable, which length is [illegible] The unit KI-I2MP is supplied by the A.C. II5v 400 c[illegible] The voltage feed the primary winding of the transfo[illegible] which is placed in the unit. As it was menshioned [illegible] h.v. rectifier is a kind of Lature circuiting. The [illegible] supply of the other tubes (except the diode cl[illegible] R.F. oscillator) is carrird out by the ordinary [illegible] rectifier 6Ц5C. To decrease the pulsation, there is [illegible] filter C2I, R27, C22. The M.V. and amplifier tu[illegible] supplied by the 250v - 280v voltage. The pre-bl[illegible] receives its 350 - 380v voltage from the same rect[illegible] before the filter.

To obtain the nominal value of the carrier frequency, the oscillator tube shoud be heated preluminary. So before the unit switching on the heating voltage is applied to the tube ГИ-I36 filament. The +27v. is given to P-I through the plug Ш-I5 pin I2. The relay P-I commutates the filament supply from the transformer filament winding to the plug Ш-I5 pin II and ground. The heating voltage (II - II.5 v) is at the pin II. After the I5-minute heating the +27v is taken away, the relay releases and commutes the tube ГИ-I36 filament to the transformer again. After that the unit is ready for operating.

§ 12. The unit KI-I3M elementary diagram.

The main part of the unit KI-I3M diagram consists of the junction cables and the seventeen plug connection. The nine plug connection are provided for bonding with the Radar units (Ш I ÷ Ш8, I5). The motor-alternators MA-250M and MA-500M making the A.C. II5v 400C voltage are jointed with the plugs Ш-I7 and Ш-I8. The Radar is power supplied by the missile-born 27v source through the plug Ш-I4 and by the unit KI-IOM five rectified voltages through the plug Ш-9. The Radar may be connected with the mother-ship monitoring board DK-I7M and with the bench board K-I09 by means of the plugs Ш-II and Ш-I3 accordingly. The plug connection Ш-I2 serves for conpling АП K-5BK. There is two type ЕМ 4500.002 relays in the unit. The relay P-I disconnects the -I47v network, when the command N 2 look on or there is a mother-ship monitoring with the command N 2 imitation by means of the board DK-I7M.

The relay P2 provides switching of the motor-alternators MA-250M and MA-500M. The switch "BI" is connected with the relay P2 winding . When the Radar should be switched on by means the board K-I09 switch it is necessary to set the toggle-switch "BI" in the position "On". So the motor-alternators will be switched on by giving the +27v from the board K-I09 to the relay winding.

It the board K-I09 is not using, the switching of the motor-alternators is carried out by using the toggle-switch "B" only.

The switch "B2" provides the unit KI-7M switching on. The switch "B3" provides the unit KI-I2MP switching on. The variable resistor RI carry out the precise setting of the MA-500M output voltage. Since RI is in the exitation winding net work, its value variance governs the MA-500M output voltage.

The variable resistor R2 carry out an analogical function with a relation to the motor-alternator MA-250M. The transformer TP-I provides the unit KI-9M tube filament supply.

The unit preservation from on accidental failture and shorting of the conductors is carried out by the safety fuses in the +27v and II5v networks.

S-E-C-R-E-T

CHAPTER VI

STRUCTURE OF THE UNITS

1. Unit K1-0

The unit K1-0 (shock-absorbing framework) is a rectangular cast-in frame, having pockets for installation of the units K1-5MP, K1-6M, K1-8M, K1-9M and K1-10M. An aluminium bottom sheet is fastened to the framework by means of 14 screws. To fix the units in the framework, washers are fastened on the framework bottom; studs of the units are introduced into the washer sockets.

To fasten each unit, bushings with the thread M4 are provided at the framework top part. The front and rear sides of the framework are covered with dural holed shield.

On the right side of the framework there is a boss with four fixing bushes to install the units K1-4aM and K1-4бM. On the same boss two brackets are fastened to prevent the units K1-4aM and K1-4бM from mechanical damage. There is four floating bushings with thread M6, destined to fasten the units K1-4aM K1-4бM in the right wall of the framework.

The frame of the framework has four bosses on its corners (on the right and left sides below). The bosses are to be mounted on the shockabsorbers AD-8. Fastening of the frame must be carried out by means of bolts M6x20. The Radar grounding crosspiece thimbles are to be placed under the bolt heads.

On the right wall of the framework the Radar designation is fastened with two screws.

In installing the framework in an object "KC", multy-layer foamed rubber dampers are to be installed on the upper framework corners to prevent displacement of it along the axes "X" and "Y".

2. Unit K1-1M

The dielectric rod, the waveguide adapter and the waveguide are fastened on a special bracket. The bracket is cast integral with the base. The base has four holes by means of which the unit is fastened to the "KC". A metal cap prevents the dielectric rod from damage.

The cap must be removed when the unit KI-IM is to be installed !

The waveguide ends with round flange, having thread. There are locking screws on its ferrule to fasten rigidly the antenna to the bracket.

3. Unit KI-3M

The unit consists of copper weldless pipes (24 mm x 10 cross-section). All the sections are interconnected by means of flanges, fastened with four screws. On one side of each connection an ordinary flange is provided, on other side a choke-flange is provided. The connection of this type staves off U.H.F. energy loss in the joint. Top part of the waveguides is painted to prevent from moisture effect. A circular rubber gasket is placed in the choke-flange socket for the same purpose. There are some unpainted belts on the waveguides. The belts are destined for the furrels, fastening the waveguide to the "KC" body. One section of the unit is made in a pleated form to prevent the units KI-4aM and KI-3M from damage, when the Radar K-IM, installed on shockabsorbers, is subjected to vibration.

4. Unit KI-4aM

The unit is made from waveguide pieces having the same cross-section. The mixer section input and output as well as lateral arms of the doble triplet end with flanges. The mixer section output ends with choke-flange and the klystron section output ends with plane flange.
A klystron holder is installed in arm 3 of the doble triplet. A klystron holder is manufactured in form of cast cylinder with a cap.

The mixer section has a special pocket to install the crystal. The signal drainage is carried out by means of a U.H.F. cable, which ends with an angular plug. The mixer chamber and the klystron section are fastened to a common metal plate on brackets. A Г-shaped bracket is placed on the same plate. The bracket serves for plug-connector fastening. The plug-connector is used to feed filament and plate voltages to the klystron K-38. The plate is fastened to the framework by means of studs and screws.

5. Unit KI-4bM

The unit is made from two waveguide pieces, having the same cross-section and connected so that the wide end of one piece is matched with the narrow end of other piece. The pieces are connected electrically by means of two slots of the antiphase coupler.

The crystal holder consists of an binding assembly, connected directly to the mixer housing, and contacting assembly, insulated from the housing (d.c.implied). The crystal holder ends with an angular contact, which is used for connection of the crystal mixer to the I.F. preamplifier. The input and output of the mixer section end with waveguide flanges.

The mixer section is fastened to a metal plate on brackets. The plate is fastened to the framework by means of studs and screws.

6. Unit K1-5MP

The unit K1-5MP is a brass chassis, on which are located all the circuit components. On one side of the chassis the unit tubes are fastened, on other one the mounting elements are fixed. The unit tubes are protected with shield-holders and are located in four rows in accordance with the unit channels. There are tuning plungers on the tube side; the plungers are used to tune IFA circuits. Besides, filament transformer with its filters is fastened on the tube side. The trasformer is covered with a shield. Monitoring jacks, located on the chassis, are used in tunin the unit. All the unit components, fastened on the tube side of the chassis or on the unit front panel, have appropriate engraved inscriptions.

The plug cknnector Ш7 is located on the unit front panel. The connector Ш7 serves for voltage supply to the unit and for connection of the unit K1-5MP to other units. On the unit front panel the cable Ф30 plug input jack, the plug output jacks of the synchronization channel Ф26, channel ES Ф27 and channel A.F.C. Ф29 are located too.

On the unit front panol the switch B-1 and axes of the potentiometers "пермод Б.Г.синхр." ("cycle of blocing g."), "ручн." ("manual"), " " and "АЧК" ("A.F.C") are mounted. The potentiometers "ручн." ("manual") and "АЧК" ("A.F.C") are used to tune the unit simultaneously with the unit K1-4aM.

To facilitate the unit output voltage monitoring, monitoring jacks are mounted in parallel with the UHF output jacks.

The unit has two shields to avoid stray couplings between the channels. The shields divide the unit in 3 compartments. Each compartment serves for one channel mounting. The unit cover is fastened with screws, which ensure reliable contact between the chassis and the cover. The unit is fastened in the frame by means of special screws and studs.

7. Unit K1-6M

The unit chassis is made from dural and has the following dimensiones: 250x295x120. On the top side of the chassis tubes, capacitors (МБГП type), potentiometers R170, R147, relay P3, pulse transformer BM-4-720-001, filament transformer and other components are mounted.

The time-motor is fastened on the chassis from above.

On the front panel the following potentiometers are mouted:

1. "Баланс "у" - Balance "Y"
2. "Баланс " " - Balance "Z"
3. "Ампл.опорных напряжений " - "Reference voltage amplitude".
4. "Фаза опорных напряжений " - "Reference voltage phase"
5. "Усиление Ɔ " - "Amplification "D"
6. "Усиление Я" - Amplification "Я"

The knobs of the potentiometers "Amplification "D" and "Amplification "Я" have limbs with divisiones.

On the front panol of the unit the plug connectors Ш-5 and Ш-6, UHF plugs Ф24, Ф25, Ф26, Ф27 and Ф28, as well as the monitoring jack "КП синхр." "CF synchr" are mounted.

The unit mounting side is protecled with a cover, which is fastened by means of screws on each side and by using special screws from below.

8. Unit K1-7M

The unit K1-7M structure is described in the elementary diagram description.

9. Unit K1-8M

The unit is mounted as an assembly, consisting of two subunits: K1-8aM and K1-8бM.

The unit K1-8aM is located directly on the unit K1-... plate. The unit is a completely shielded box.

The input circuit is mounted directly at the crystal and is connected to the latter by means of a UHF plug.

The output cable is built-in in the chassis, other end of the cable has a plug to be conneted to the unit K1-8...

The unit K1-8бM is a brass chassis, on which all the circuit components are mounted. On one side of the chassis the unit tubes are fastened, on other one the mounting elements are fixed.

The unit tubes are protected with shields. On the tube side there are plungers of the IFA circuits and the filament transformer is mounted. The monitoring jack Г5. is to be used to tune the unit only.

All the unit components, mounted on the tube side of the chassis or on the unit front panel have appropriate engraved inscriptions.

On the front panel of the unit K1-8M the plug connector Ш-2, control potentiometer MVC, monitoring jacks ES, AGC, MVC and swithe B1 are mounted. There are the following plugs too:

1. Output to the unit K1-6M Ф24
2. Output to the unit K1-9M Ф23
3. Input Ф20
4. Strobe input from the unit K1-9M Ф22.

The unit chassis is divided with a crosspieceshield, separating mounting side.

On one side of the chassis IFA stages and the second detector and video-amplifier stages (to the unit K1-6M), which are separated with a shield are placed in line.

On other side of the chassis AGC stages, video-amplifier stages (to the unit K1-9M), filament transformer and a shielded compartment of the feeding filters are placed.

The mounting elements are protected with a cover, fastened with screws. A guide stud, fixing the unit in the framework compartment, is located on the rear side of the unit.

10. Unit K1-9M

Unit chassis dimensiones are 285x135x49. Tubes, capacitors (type МБГП and КБГ-МН), relays РС-13 and РСМ-2, delay line, type ВМ-4-720-001 pulse transformers etc. are mounted from above.

The main mounting elements are located on the chassis from below. The following potentiometers are fastened on the front panel:

1. Control "диапазон поиска R12 - "search range" R12.
2. Cintrol "скорость поиска" R21 - "search speed" R21.
3. Control "напряжение накопителя" R23 - "accumulator voltage" R23.
4. Control "начало поиска " R53 - "search starting" R53.

The plug connector Ш4, UHF plugs Ф22, Ф23, Ф25 and monitoring jacks "strobe" and "accumulator voltage" are mounted on the front panel.

The mounting side of the unit is protected with a cover which is screwed to the side walls of the chassis.

11. Unit K1-10M

Two plug connectors Ш9 and Ш-35 and the output voltage control potentiometers are located on the unit front panel. All potentiometers have engraved inscriptions.

The plug connector Ш-9 receives all the voltages, produced by the unit. The same cable feeds the voltage ~ 115v, 400c, from the motor-alternator МА-500М to the plyg connector.

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The plug connector Ш-35 is to be used only for monitoring of the rectified voltages.

A chassis is fastened perpendicularly to the unit front panel. All the unit components: tubes, capacitors, resistors and chokes are located on this chassis. The tubes are fastened by means of special tube-holders.

The unit frame has П-shape ribs, which ensure appropriate regidity.

12. Unit K1-11

The antenna is an open end of the waveguide, (72x34 cross-section), corness of which are cut off simmetrically. A metal rod (ø 5 mm) is located in the outlet hole of the waveguide perptndicularly to its wide walls. Nip between the edge and the rod axis is 10,5 mm. The antenna feeding is carried out by means of a coaxial lead, one end of which ends with the exciter and other one ends with a standard 50 ohom UHF plug for the cable PK-47.

There is a hole in the wide wall of the waveguide. The hole ensures access to the exciter.

13. Unit K1-12MP

The unit K1-12MP is a hermetically sealed instrument. The sealing is necessary to ensure normal pressure within the unit, when it is elevated at an altitude. When the pressure drops, a breakage is possible: the unit max.voltage is 2600v.

Within the unit housing the following components are fastened:

UHF generator chamber, two UHF plugs, sealed plug connector. The UHF plug Ф28 serves for the unit K1-12МР ... ring, other plug Ф31 serves for UHF cable connection (the cable is connected to the K1-11 radiating antenna). The plug connector Ш-15 feeds voltages, necessary for the unit.

The capacitors, pulse transformers, power transformer, relays РС-13 and РЭС-6 and tube sockets are fastened on the chassis.

The unit cover is fastened with 6 screws, which are screwed in the unit honsing. To ensure scaling 2 rubler rings are glued in the unit housing, leather gaskets and rubber gaskets ВШ-15 are put on the plugs.

13. Unit K1-13M

The unit is a flat, rectangular box having removable top cover. All mounting elements are placed inside the unit. Plug connectors, variable resistors and switches are placed on the lateral walls.

Some plug connectors are manufactures as a cable lead; they are fastened at the ends of short cables, which go out of the box through bushings. Variable resister axes are mounted on the top wall and have screw-driver slots. Each resistor has engraved inscription, which indicates motor-alternators and voltage to be controlled.

The switches BI,B2 and B3 are mounted on the bottom wall and have marks, corresponding to switching on or switching off of the motor-alternators or units.

All the bunched connecting wires, relays and filament transformers are located on the box bottom.

The fuse plate is placed in the upper part of the box; two mounting panels are located below. The box is protected from above with a top cover, having a little hatch against the fuse plate.

LIST OF PHOTOS

ABBREVIATIONS

U.H.F. - ultra high frequency
E.S.L. - equisignal line
A.M. - amplitude modulation
A.F.C. - automatic frequency control
R.F. (signal) - radio drequency signal
C.W. - continuons wave
I.F. - intermediate frequency
M.V.C. - manual voltage control
A.C.L. - automatic gain control
a.c. - alternative current
d.c. - direct current

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